A STUDY OF SOLITARY PULMONARY NODULE

IN 50 CASES

Dissertation Submitted to

THE TAMIL NADU

Dr. M.G.R Medical University

for

M.D. DEGREE IN GENERAL MEDICINE

CHENNAI

March 2008

DEPARTMENT OF GENERAL MEDICINE

COIMBATORE MEDICAL COLLEGE & HOSPITAL

COIMBATORE

CERTIFICATE

This is to certify that the Dissertation titled **" A STUDY OF SOLITARY PULMONARY NODULE IN 50 CASES "** herewith submitted by **Dr. SOUMITRA SINHA ROY,** M.D**.,** Post Graduate in General Medicine, Coimbatore Medical College, to the Tamilnadu Dr. M.G.R. Medical University is a record of bonafide research work carried out by him under my guidance and supervision from Jan 2006 to Aug 2007.

Dr. M. Ramasamy, M.D.
Prof. and Unit Chief

Dr. K. Umakanthan, M.D.
Prof. and Head
Department of Medicine

Dr. HEMALATHA GANAPATHY, M.D.,
DEAN

DECLARATION

*I solemnly declare that the Dissertation titled "**A STUDY OF SOLITARY PULMONARY NODULE IN 50 CASES**", was done by me at Coimbatore Medical College & Hospital during the period from January 2006 to August 2007 under the guidance and supervision of Prof. M. Ramasamy, M.D.*

This dissertation is submitted to the Tamil nadu Dr. M.G.R Medical University towards the partial fulfillment of the requirement for the award of M.D. Degree (Branch I) in General Medicine.

Place: Coimbatore

Date : **Dr. Soumitra Sinha Roy**

ACKNOWLEDGEMENT

I sincerely thank **Dr. HEMALATHA GANAPATHY, M.D.,** Dean and **Dr. T.P.KALANITI, M.D.,** former Dean, C.M.C Hospital, Coimbatore for having permitted me to undertake the study in this prestigious institution.

It is a great pleasure to express my sincere thanks to **Prof. K. UMAKANTHAN, M.D.,** Head of the Department of Medicine, C.M.C Hospital, Coimbatore for his able stewardship in the preparation of this work.

I gratefully acknowledge my indebtedness to **Prof**. **M. RAMASAMY, M.D.,** and **Prof. S. VEERAKESARI**, **M.D**., my Unit Chiefs for their valuable guidance in the preparation of this dissertation work.

I gratefully acknowledge the cooperation, goodwill and assistance rendered to me by the departments of Microbiology and Radiology during the course of my study.

I whole heartedly thank my entire unit Assistant Professors viz. **Dr. V. NEELAKANTAN, M.D., Dr. M. RAVEENDRAN, M.D., Dr. T. GEETHA, M.D.,** for their professional assistance in shaping out this dissertation work.

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INTRODUCTION

This is a study of 50 cases of Solitary Pulmonary Lesion presented at Coimbatore Medical College Hospital, a tertiary care hospital in south India. The purpose of this study being to diagnose the different causes of Solitary Pulmonary Lesion with special emphasis on early detection of bronchogenic carcinoma.

- A solitary pulmonary nodule (SPN) is a small, round or egg-shaped lesion in the lungs. SPNs are typically asymptomatic, and they are usually noticed by chance on a chest x-ray that has been done for another reason. They are usually less than 3 cm in diameter (no larger than 6 cm)[1] and are always surrounded by normal, functioning lung tissue.
- The finding of a Solitary Pulmonary Nodule on a chest x-ray is a diagnostic dilemma often faced by many clinicians. The differential diagnosis ranges from a broad group of benign, infective, inflammatory, vascular, traumatic, congenital and malignant causes[2]. In India, upto sixty percent of all SPNs could be benign[2,5] due to high rate of infections[30] specially TB. Malignant SPNs may be primary stage IA lung cancer or metastases[3]. Upto

30% of all bronchogenic carcinoma can present as SPN. Upto 88% of malignant SPNs in stage IA are resectable & hence 5 year survival rate is excellent, approaching 70-80%[3,4]. Unfortunately, approximately one half of all lung cancers have extrapulmonary spread at the time of diagnosis. As a result, the average patient with a diagnosis of lung cancer has a 5-year survival of only 10 to 15%[5]. Therefore, it is prudent that malignant form of SPN are promptly evaluated and managed. In general, all SPNs should be considered malignant until proven otherwise[13].

- A confirmed diagnosis of a benign lesion like infection, granulomata and benign lung tumour also obviates the need to undergo surgical resection of the lesion. Thus unnecessary exploratory thoracotomy with its attendant morbidity can be avoided.

AIM OF THE STUDY

With worsening industrial pollution and rampant smoking habits, the incidence of bronchogenic carcinoma is rising menacingly. Till date the treatment is mostly palliative rather than curative, unless diagnosed early. Thus the objective of this study is -

- To diagnose early cases of bronchogenic carcinoma who have excellent 5 year survival rate.
- This study also focuses on diagnosing cases of tuberculosis, which are completely curable and aims to differentiate it from other infective, granulomatous and benign causes of Solitary Pulmonary Nodule.
- To study the various clinical and pathological presentations of Solitary Pulmonary Nodule presented in this hospital.

REVIEW OF LITERATURE

Background:

A Solitary Pulmonary Nodule (SPN) is defined as a single discrete pulmonary opacity surrounded by normal lung tissue and is not associated with adenopathy or atelectasis. The differential diagnosis may be broad but implications rest on whether the lesion is benign or malignant.

Radiographically, a nodule is defined as a lesion smaller than 3 cm[1]. Anything larger than 3 cm is termed a mass.

Pathophysiology:

Pathophysiology of pulmonary nodules depends on etiology.

Frequency:

SPNs are fairly common. Screening studies in adults reveal SPNs in 1-2 per 1000 chest radiographs[80]. In the United States, an estimated 150,000 SPNs are detected annually[2]. Overall, incidence of malignancy ranges from 10-70%[2,6,7,8]. The higher incidence is largely the result of a selection bias, depending on the population under study (e.g., age, smoking status,

referral pattern, and location of the study[9]). Indian scenario as assessed by various previous publications is similar.

Mortality / Morbidity:

Prognosis depends on whether the lesion is benign or malignant and the stage of the lung cancer on presentation.

Following resection of a solitary bronchogenic carcinoma (stage IA), the 5-year survival rate is approximately 70-80%[53].

Sex:

No difference in incidence exists between males and females[2,5].

Age:

Solitary nodules can occur at all age levels. Early on, they usually are secondary to a benign lesion. The risk of malignancy increases with age.

Clinical Presentation:

Most SPNs are asymptomatic. The goal of investigating an SPN is to differentiate a benign lesion from a malignant lesion as soon and as accurately as possible.

Important features in the patient history include the following:

- Age - Risk of developing malignancy increases with age[9]
    - 3% Risk at age 35-39 years
    - 15% risk at age 40-49 years
    - 43% risk at age 50-59 years
    - Greater than 50% risk in patients older than 60 years
- Smoking history[9]
- Prior history of malignancy[9]
- Occupational risk factors for malignancy - Exposure to asbestos, nickel, chromium, vinyl chloride, and polycyclic hydrocarbons
- Previous history of tuberculosis or pulmonary mycosis

Preferred Investigation:

Chest radiograph usually is the initial examination. Most SPNs are discovered as an incidental finding. With recent introduction of low dose CT chest scans[16,36] as a screening tool for lung cancer, more and more smaller nodules will be detected requiring evaluation. As more large-scale studies become available, positron emission tomography (PET) and single-photon emission computed tomography (SPECT) will become important imaging tools.

Limitations of Techniques:

Chest radiographs demonstrate poorer resolution than chest CT scans in determining degree of calcification or size. Visualisation of some nodules may be difficult because of superimposed structures causing 20-50% of missed diagnosis[14,15,16,17,18,19].

Chest CT scans are limited by its cost and the need for intravenous contrast, which carries a risk of an adverse reaction. CT is not as easily available and portable as chest radiographs.

Nuclear medicine imaging (PET and SPECT scan) is considerably more expensive than a chest CT scan or MRI study. PET and SPECT are available in few places only in India.

DIFFERENTIAL DIAGNOSIS

Malignant lesions:

Bronchogenic carcinoma - Small cell, Large cell, Adenocarcinoma, and Squamous cell

Carcinoids

Solitary metastases

Benign lesions:

Benign neoplasms - Hamartomas, Lipomas and Fibromas

Vascular lesions - Arteriovenous malformation

Infectious granulomas - Tuberculosis, Atypical mycobacterial infection, Histoplasmosis, Coccidioidomycosis and Blastomycosis

Other infections - Aspergilloma, Ascariasis, Echinococcal cyst and Bacterial abscess

Noninfectious granulomas - Rheumatoid arthritis, Wegener granulomatosis and Sarcoidosis

Developmental lesions - Bronchogenic cyst

Others conditions - Hematoma, Bronchiolitis obliterans-organising pneumonia, Pseudo-tumour, Pulmonary infarction, Rounded atelectasis and Mucoid impaction

False Positives / Negatives - Some SPN mimickers include nipple shadows, soft tissue tumors, bone / rib shadows and pleural plaques

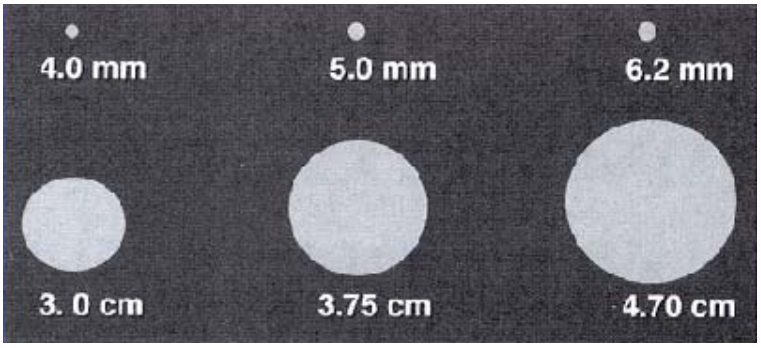
RADIOGRAPH

Often, SPNs are discovered first as incidental findings on chest radiographs. The first step is to determine whether the nodule is pulmonary or extra pulmonary. A lateral chest radiograph, fluoroscopy, or CT of the chest often helps determine the location of the nodule.

Usually, nodules are identifiable by the time they are 8-10 mm on chest radiographs. Occasionally, SPNs can be visualised at 5 mm in diameter. Chest radiographs can provide information regarding nodule size, growth rate, margin characteristics, and calcification pattern, which can aid in the assessment of benign versus malignant lesions.

- Nodule size: Nodules greater than 3 cm in diameter are more likely to be malignant, while those less than 2 cm are more likely to be benign[31]. But size alone is of limited value. In individual patients, small nodules can be malignant and larger nodules can be benign.
- Growth rate:
    - Comparison of previous chest radiographs of the patient allows assessment of the growth rate. The growth rate refers to the doubling time of a nodule, i.e., doubling in volume. On chest radiographs, a nodule appears as a 2-dimensional representation of a 3-dimensional structure. The volume of a sphere equals $4/3\ \pi r^3$; therefore, a 26% increase in diameter on a chest radiograph represents one doubling in volume. For example, an increase from 1-1.3 cm equals one doubling. A 1-2 cm increase relates to an 8-fold increase in volume.

- Bronchogenic carcinomas usually have a doubling time of 20-400 days[24].
- Doubling times shorter than 20-30 days are seen in infections, infarction, lymphoma, or fast-growing metastases[23].
- Doubling times greater than 400 days are typically benign[20,21].
- Absence of change in size of a nodule over 2 years is highly suggestive of a benign lesion.
- Determination of size of small nodules is not without error. On chest radiographs, a 3-mm enlargement may be difficult to appreciate. The use of digitally enhanced films may allow more accurate measurement of size.



The above picture depicts the effect of initial nodule size on perception of growth. Our eyes perceive the change of diameter better, rather than the increase in volume. The smaller nodule appears to grow more slowly than the larger one, even though both are doubling in volume at the same rate.

- Margin characteristics: Benign lesions tend to have well-circumscribed smooth borders. Malignant nodules typically have irregular, lobulated, or spiculated (corona radiata) borders. Of the margin descriptions, the spiculated border is the most sensitive in predicting malignancy[25,26]; however, it is not unusual for a malignant lesion to have a smooth contour, specially metastasis[25,26].
- Calcification: Calcification within a nodule is more likely to be seen in a benign nodule; however, approximately 10% of malignant nodules demonstrate calcification. In benign lesions, 5 patterns of calcification are seen commonly, including diffuse, central, laminar, concentric, and popcorn (chondroid) calcifications. The popcorn pattern typically is described in hamartomas. A stippled or eccentric pattern is seen most commonly in malignant lesions [19,28]. CT scan allows a more accurate detection and assessment of the calcification pattern than plain film[22].

.CT SCAN

CT thorax allows better assessment of nodules. The advantages of CT over plain film include the following:

- Better resolution: Nodules as small as 3-4 mm is detectable. Morphologic features of specific diagnosis are better visualised (eg, rounded atelectasis, arteriovenous malformations).
- Areas that are difficult to assess on plain radiography are visualised better on CT, such as the lung apices, perihilar regions, and costophrenic angles[27,28,29].
- Multiple nodules can be detected on CT scans.
- Malignancy can be staged using CT.
- CT can help guide needle biopsy.

CT densitometry

CT densitometry measures the attenuation coefficients of a particular lesion to determine its density. The results are expressed in Hounsfield units (HU).

CT densitometry allows for detection of occult calcification that may not be appreciated visually, even on high-resolution thin-section CT of the chest. The difficulties with this technique have been in determining the appropriate level of the attenuation coefficients used to classify a lesion with a high probability of being benign. One study[25] looking at 91 nodules known to be malignant or benign proposed a cutoff of greater than 164 HU for benign lesions. In another study[26] of 85 nodules

classified as benign using 185 HU as a cutoff, 9% were found to be malignant at biopsy. Densitometry in this setting may provide useful information if used in context with other clinical and radiologic features.

Densitometry also allows detection of fat within a nodule, which is a common feature of benign nodules, especially in hamartomas.

Other features of CT include the following:

- Contrast enhancement: Malignant nodules tend to have greater vascularity than benign nodules. Nodular enhancement of less than 15 HU suggests that a lesion is benign, and enhancement of greater than 20 HU is more likely associated with malignancy (sensitivity 98%, specificity 73%)[33].
- Feeding vessel sign: This sign may be seen in hematogenous or vascular causes of pulmonary nodules such as metastatic deposits or septic emboli.
- Cavity wall thickness[25,32]: Cavitation can be seen in both malignant and benign nodules. While a thin-walled cavity is highly suggestive of a benign lesion ($\leq$1 mm), a thick-walled cavity usually is indeterminate and is present in both benign and malignant lesions.

MRI

MRI provides better imaging for pleural, diaphragm, and chest wall disease than CT when staging lung cancer. MRI is comparable to CT in assessing mediastinal involvement[28,29] and is less useful in assessing the lung parenchyma (especially assessing pulmonary nodules) because of poorer spatial resolution. Since MRI costs more and is less available, MRI use is reserved for tumors that are difficult to assess on CT (eg, Pancoast tumours).

ULTRASOUND

Ultrasound has a limited role in the form of percutaneous biopsy of larger peripherally based lesions for evaluating a SPN.

NUCLEAR MEDICINE

Recently, nuclear medicine imaging has been studied for use in evaluation of SPNs. Positron emission tomography (PET) and single - photon emission computed tomography (SPECT) imaging have been approved for use in the United States for evaluating pulmonary nodules.

PET imaging

Malignant cells have higher metabolic rate than normal cells; therefore, glucose uptake is higher. Thoracic PET imaging uses the isotope fluorine-18 bound to a glucose analog to make fluorine-18-fluorodeoxyglucose

(FDG). Increased FDG uptake is seen in most malignant tumours and is the basis of the PET study used to differentiate malignant from benign nodules.

FDG uptake can be quantified using the standardised uptake ratio (SUR) to normalise measurements for a patient's weight and injected dose of radioisotope. This allows comparison of uptake between different lesions and patients. SUR greater than 2.5 has been used by some[34,35,36] as a marker of malignancy.

An additional advantage of FDG-PET imaging is better detection of mediastinal metastases[34], improving the staging of lung cancers.

SPECT imaging

SPECT scanners have the advantage of being more readily available than PET scanners. Depreotide is a somatostatin analog labeled with technetium Tc 99m, which has been shown to bind to somatostatin receptors expressed on non-small cell carcinomas.

Use of SPECT scanning has not been evaluated in a larger series.

Overall, both FDG-PET and SPECT imaging are promising noninvasive techniques for differentiating malignant lesions from benign lesions and aiding in the assessment of indeterminate lesions.

In a study of a small series of patients, depreotide uptake demonstrated a sensitivity and specificity of 93% and 88%, respectively, for malignancy[38].

False Positives/Negatives: Limitations of FDG-PET imaging include the following:

- False-positive findings can occur in other metabolically active conditions that produce pulmonary nodules, such as infectious granulomas or inflammatory lesions.
- False-negative findings can be seen in the following:
    - Small tumours: The resolution of current PET scanners is 7-8 mm; therefore, they may miss tumors smaller than 10 mm.
    - Tumours with low metabolic rates, such as carcinoid and bronchioalveolar cell carcinomas, may not be distinguishable from background uptake[37].
    - High serum glucose concentrations compete in cells with FDG; therefore, uptake of the radioisotope is reduced.

INVASIVE INVESTIGATIONS

After clinical and radiologic assessment of an SPN, all patients can be divided into 1 of 3 groups as follows:

- Patients with benign lesions: Benign status is based on patient age, younger than 35 years without other risk factors, stability of the SPN over 2 years on chest radiograph, or a benign pattern on chest radiograph. These patients have a low likelihood for malignancy and should be followed with serial chest radiograph or CT every 3-4 months for the first year and every 4-6 months in the second year.
- Patients with malignant lesions: Malignant status occurs with clinical and radiologic features in patients who have a high likelihood for a malignant lesion that will progress to a thoracotomy for removal.
- Patients with indeterminate lesions: Most patients fall into this category. As many as 75% of these patients have malignant nodules on further evaluation.

Bronchoscopy and biopsy

- Usefulness is limited in lesions smaller than 2.0 cm.
- In lesions larger than 2.0 cm, the yield for malignancy varies from 40-69%[45,46,47,48,49].
- Yield is higher for nodules located in the inner one third[46] of the lung fields or in close approximation to a bronchus on CT scans.

Percutaneous needle biopsy

- This technique can be performed under fluoroscopy or with CT guidance.
- Needle aspiration can be performed using a 21-gauge needle or needle aspiration plus core biopsy can be performed using an 18-gauge or 19-gauge needle (higher yield[42] with greater risk for pneumothorax[44]).
- Yield is highest for peripheral nodules.
- Sensitivity and specificity for malignant lesions is 80-95% and 50-88%, respectively[39,40].
- Sensitivity for a specific benign diagnosis (eg, granuloma, hamartoma) is 11-68%[41].
- Controversy exists concerning needle aspirations / biopsies with negative results (ie, without a specific benign diagnosis). The negative predictive value of transthoracic needle aspiration to exclude malignancy varies from 52-88%. Options such as observation, repeat biopsy, or thoracotomy depend on the pretest probability for malignancy and patient-related factors, such as comorbid illness that may preclude a thoracotomy. A thoracotomy is indicated in patients who still have a high likelihood of malignancy.
- Using on-site cytologic analysis increases sensitivity of percutaneous biopsy[43]. The presence of a cytologist at the time of

biopsy aids in assuring the adequacy of specimens. This can both decrease complications by reducing unnecessary collection of additional samples and increase the yield by informing the radiologist of the need to obtain additional samples.

- Complications[44]
    - Pneumothorax is seen in as many as 30% of these patients and approximately 5% require a chest tube.
    - Hemoptysis is seen in 5-10% of these patients and usually is minor and resolves spontaneously.
    - Fatal hemorrhage and air embolism are rare.
- Contraindications
    - Limited pulmonary reserve (forced expiratory volume in 1st second <1.0 L)
    - Emphysema or blebs in the path of the needle
    - Coagulopathy
    - Inability to hold breath
    - Severe pulmonary hypertension
    - Contralateral pneumonectomy

Thoracoscopy or thoracotomy

- A thoracotomy and lobectomy with lymph node sampling is the treatment of choice for patients with stage IA bronchogenic carcinoma[50,51,52,53].
- In patients with an indeterminate nodule and a high probability of malignancy, a thoracotomy should be performed if the patient has adequate pulmonary reserve.
- Recently, video-assisted thoracoscopy surgery (VATS) has been used for removal of peripheral nodules with a wedge resection[52,54]. If at the time of VATS the frozen section is positive for malignancy, an open thoracotomy[55] can be performed for proper anatomic resection. If a benign lesion is found, the procedure saves the patient from the invasiveness of a full thoracotomy and lobectomy.

Assesment of probability of malignancy[9,10,11,12]:

- In determining the most effective strategy for investigating an SPN and treating the patient, developing an estimate of the probability that the nodule is malignant is important. Bayesian analysis uses likelihood ratios of malignancy for various clinical and radiological factors. The ratios are combined to produce a probability of malignancy (*PC*a).

- When the probability of malignancy is high (*PC*a >70%), a resection is warranted. Similarly, if the probability is low (*PC*a <5%), observation is recommended. For lesions with an indeterminate probability, further evaluation is necessary.

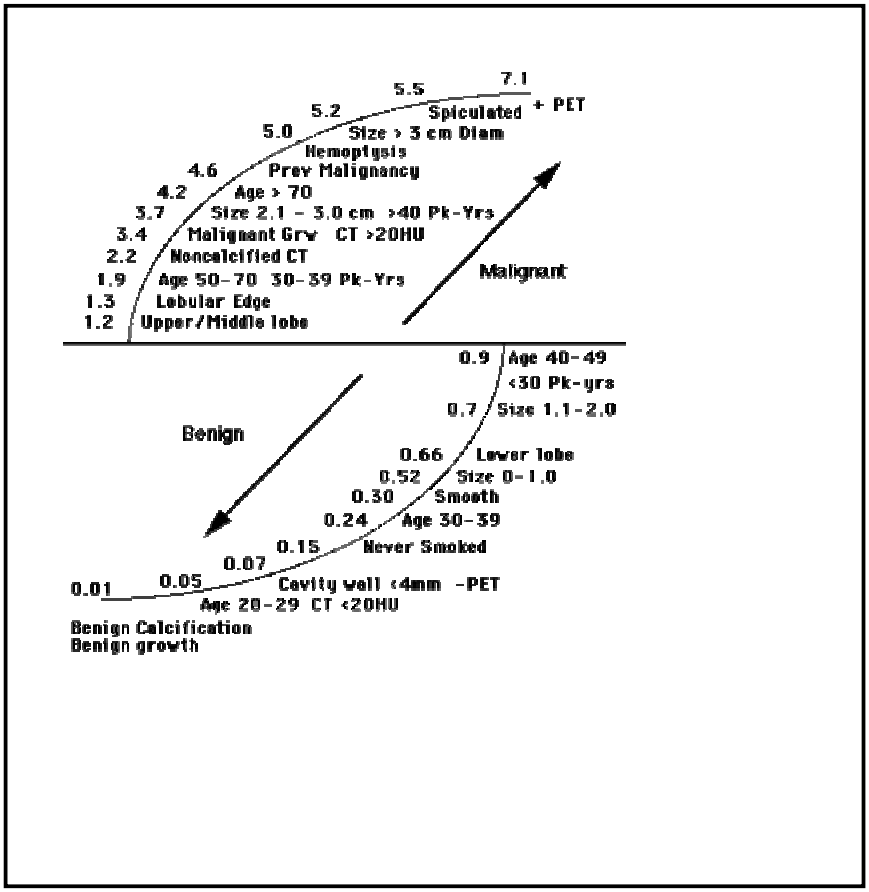
- Calculation of probabilities provides only an estimate of malignancy and it cannot be generalised in respect of all patients.

Probability of Malignancy in SPN: Bayesian Analysis[10]

The main objective of Bayesian analysis is to use all the clinical and radiographic characteristics to derive a quantitative estimate of the probability that a SPN is malignant.

This is a mathematical theorem after presentation of all data regarding the nodule (details below) to the java program which will calculate the probability of malignancy. The necessary facts are-

- Prior Probability of Malignancy:
- Clinical charecteristics: Age, Smoking (Pack-yrs), Haemoptysis, History of previous malignancy
- Radiographic charecteristics: Size (in cm), Location, Edge, Growth rate, Cavity wall thickness, Calcification
- Additional characteristics: Contrast enhancement, PET



Probability of Malignancy in SPN : Bayesian Analysis

Likelihood Ratios	
20-29 yrs	0.05
30-39 yrs	0.24
40-49 yrs	0.94
50-59 yrs	1.90
60-69 yrs	2.64
Nonsmoker	0.15
< 30 pk-yrs	0.74
30-39 pk-yrs	2
>40 pk-yrs	3.7
Hemoptysis, absent	1
Hemoptysis, present	5.08
No prev malig	1
Prev Malig	4.95
0-1 cm	0.52
1.1 - 2.0	0.74
2.1 - 3.0	3.67
> 3.0 cm	5.23
upper/middle	1.22
Lower	0.66
Smooth	0.3
Lobulated	0.74
Spiculated	5.54
Growth, not known	1
Benign growth rate	0.01
Malignant growth rate	3.4
Not cavitated	1
< 4 mm	0.07
5 - 15 mm	0.72
> 16 mm	38
Not calcified	2.2
Benign calcification	0.01
Enhancement < 15 HU	0.04
Enhancement > 15 HU	2.32
SUR < 2.5	0.06
SUR > 2.5	7.1

MATERIALS AND METHODS

Period of Study:

This study was done from January 2006 to August 2007.

Setting:

A single discrete pulmonary opacity surrounded by normal lung tissue and not associated with adenopathy / atelectasis in the chest x-ray in the following group of fifty adults was taken as the starting point of the study. In order to overcome observer bias, concurrence of four individual observers was taken as a pre-requisite to include the case in the study population.

Study Population:

a) Asymptomatic adults, who had undergone hospital run master health check up programme;

b) Patients presented with chest symptoms in medicine OPD;

c) Individuals who presented themselves for unrelated complaints in different OPDs for whom a routine chest x-ray was called for.

Inclusion criteria:

Following x-ray findings, as described by John D. Minna and Charles S. Scoggin [66,71], were taken as criteria for inclusion:

a) Cases presenting with solitary pulmonary parenchymal nodular lesion of 1- 6 cm in diameter.

b) The nodule appears to lie within the pulmonary parenchyma, with aerated lung tissue around it.

c) The lesions are round or ovoid in shape.

d) Patients may have associated minimal pneumonitis, atelectasis or regional lymphadenopathy.

e) The lesions are solitary (in some cases satellite lesions may be present) with circumscribed margin.

Exclusion criteria:

Size of the nodule >6cm

Obvious hilar, mediastinal, diaphragmatic and chest wall masses

Co-morbid conditions-

Bleeding diathesis – as assessed by BT, CT, platelet count

Pulmonary hypertension

Multiple bullous lesions

Extremely sick / dyspnoeic patient

Method:

Detailed history with special reference to age; sex; smoking habit; exposure to TB / STD; occupational risk and exposure to asbestos, nickel, chromium, polycyclic hydrocarbon; previous history of TB / pulmonary mycosis, DM, immunosuppresive disease / drugs was obtained.

A thorough clinical examination with special attention to respiratory system, para-neoplastic syndromes and signs of metastasis was done. All other systems, specially, GI tract, prostate, testis, kidney, thyroid and breast & pelvis in females were carefully examined for primary lesion.

Investigations:

Other than routine blood, urine, tuberculin test, the important investigations carried out are as follows-

- Sputum – Gram stain; AFB stain; fungal KOH stain; bacterial C/S; mycobacterium TB Culture- L-J medium or Liquid culture medium; fungal culture in sabourand agar medium; malignant cell examination were done.

- Chest x-ray – PA view mostly, with occasional lateral view and digital enhancing x-ray as needed- size of lesion, growth rate, margin characteristics, calcification pattern were looked into for assessment and differentiation between benign / infective / malignant lesions.

- CT thorax – Better visualisation and appreciation of nodule / mass is possible in CT thorax. No. and size; calcification pattern; staging for malignancy; densitometry of lesion; contrast enhancement; wall thickness; positive vessel sign were noted for differentiation between benign / infective / malignant lesions.
- CT guided percutaneous fine needle aspiration cytology / tru-cut needle biopsy – from peripheral lesions and histopathological examination of the same.

- Bronchoscopy – Broncho-alveolar lavage, brushing, bronchoscopic biopsy for centrally placed lesions were done with bronchoscopy.
- Fine needle aspiration cytology / excision biopsy of palpable significant lymph nodes, if any were done.

OBSERVATION AND RESULTS

Analysis of 50 persons presenting with Solitary Pulmonary Nodule in chest x-ray presented at Coimbatore Medical College Hospital, who met the inclusion criteria was done.

Total no. of chest x-ray screened – 4728. Incidence of SPN in this study is 1.26/ 1000 population.

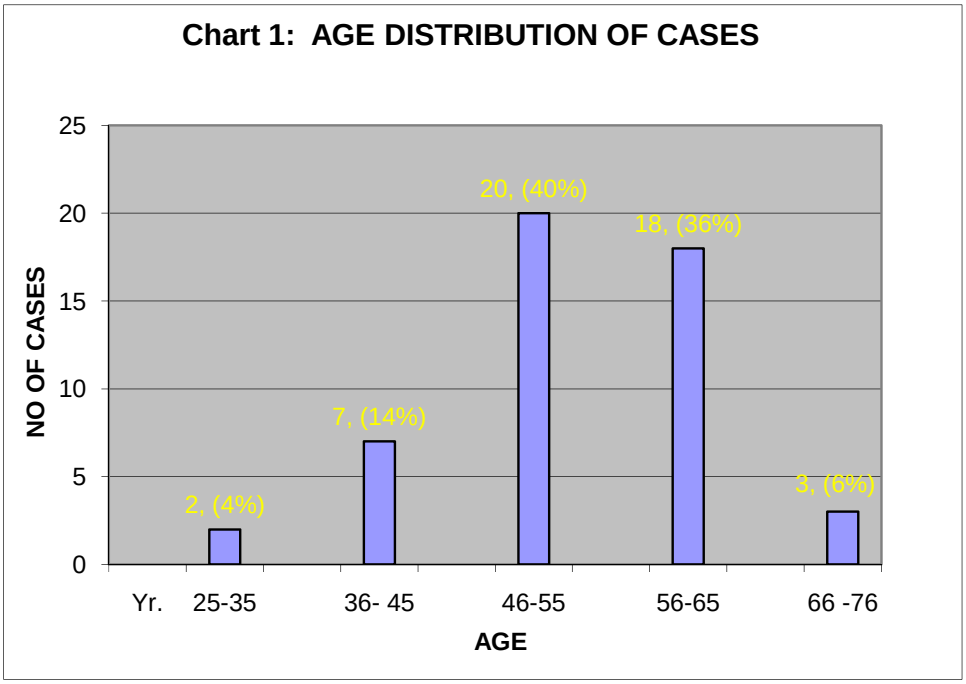
AGE and SEX DISTRIBUTION: **(Table 1, Chart 1)**

Of the 50 persons in the study 48 (96%) were male and 02 (4%) were female. Mean age was 53.3 yrs with the range being 25 to 76 yrs. Majority (76%) of the persons were in age group 46-65 yrs.

Table 1: **Total cases - 50**

AGE GROUP (yrs)	NUMBER OF CASES		PERCENTAGE
	Male	Female	
25 - 35	2	0	4
36 - 45	5	2	14

46 - 55	20	0	40
56 - 65	18	0	36
66 - 76	3	0	6

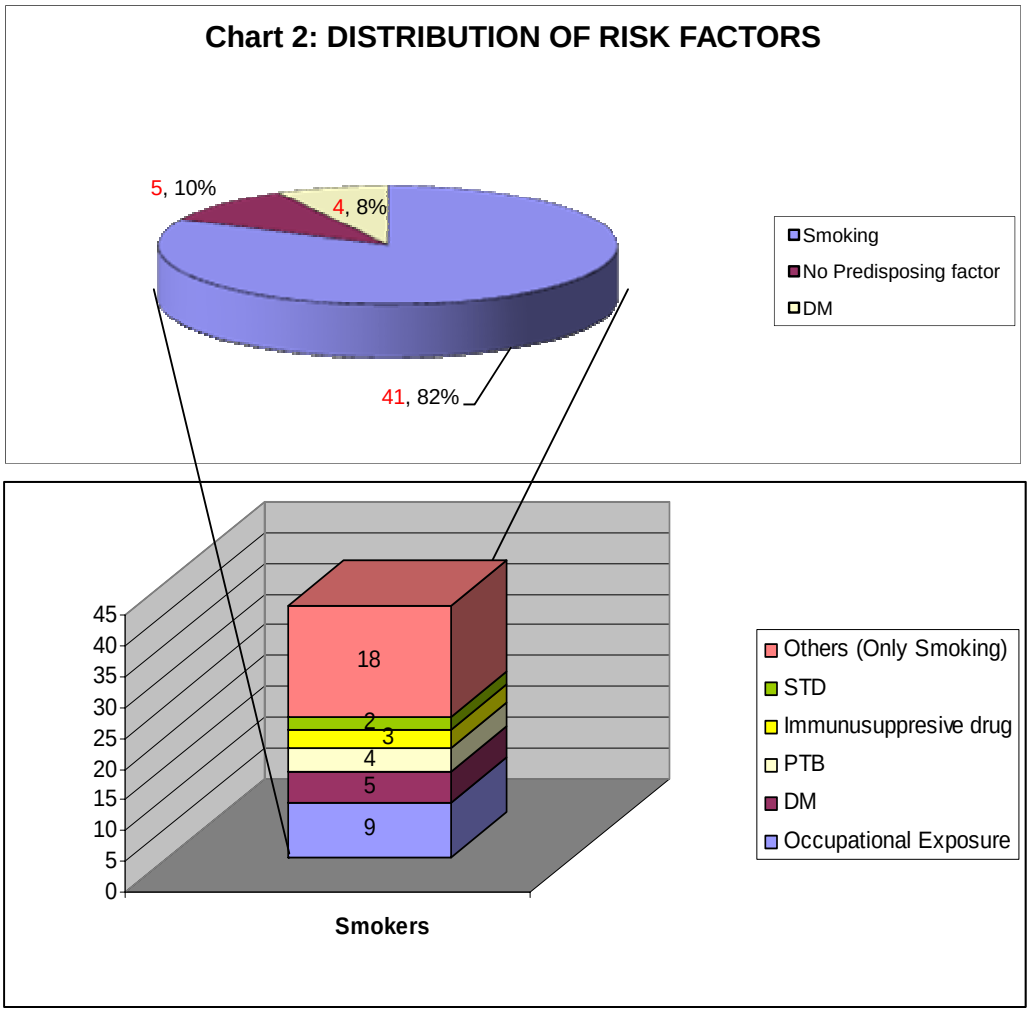


DISTRIBUTION OF RISK FACTORS AMONG CASES:
(Table 2, Chart 2)

Cases had multiple risk factors. An overwhelming majority of the 50 people studied were smoker, i.e. 41 persons (82%). Among the 41 smokers, 9 cases were also exposed to industrial waste of toxic fumes of rubber & asbestos factory. Both the males having exposure to STD were also smoker. 5 of the diabetics were smoker. Both the women were type 2 diabetic.

Table 2: Distribution of Risk factors

RISK FACTORS	NO. OF PATIENTS	PERCENTAGE
Smoking	41	82
Exposure/past h/o PTB	6	12
STD exposure	2	4
Occupational exposure	9	18
DM	9	18
Immunosuppresive Drugs	3	6
No risk factor	5	10



ANALYSIS OF CLINICAL SYMPTOMS: (Table 3, Chart 3)

A significant number of persons were chest asymtomatic i.e. 18 (36%). Commonest symptom was cough (20 persons, 40%); mostly dry cough (10 persons, 20%). Next commonest was vague ill health and weight loss (7 persons, 14%). Patients had multiple symptoms.

Table 3:

CLINICAL SYMPTOMS	NO. OF CASES	PERCENTAGE
Asymtomatic	18	36
Chest pain	5	10
Dry cough	10	20

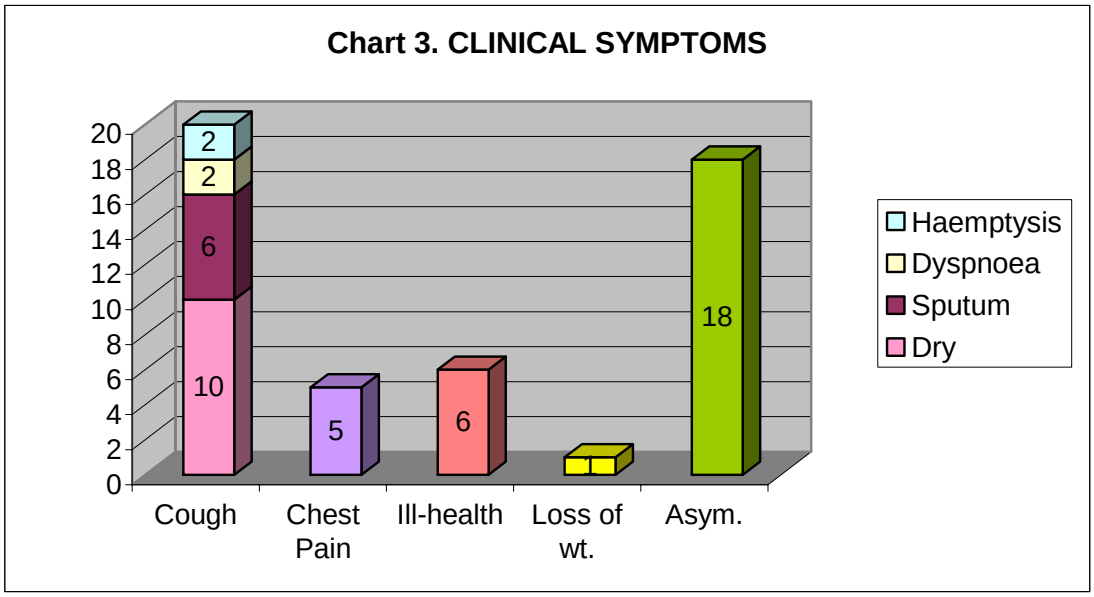
Cough + Expeectoration	6	12
Cough + Dyspnoea	2	4
Cough + Haemoptysis	2	4
Ill – health	6	12
Loss of weight	1	2

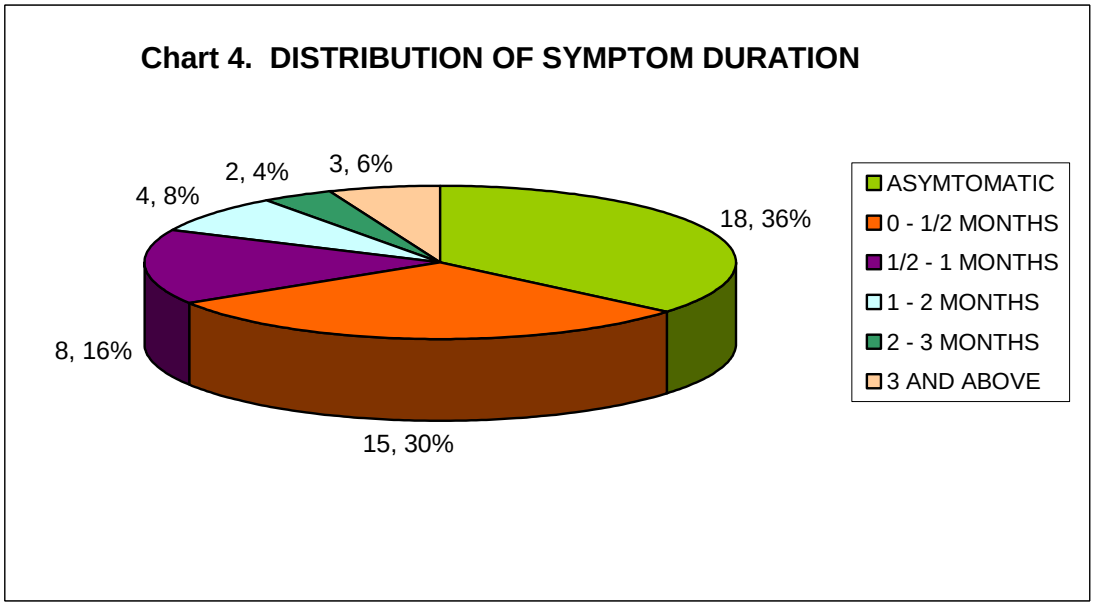
ANALYSIS OF DURATION OF SYMPTOMS: (Table 4, Chart 4)

Table 4

DURATION (MONTHS)	NO. OF CASES	PERCENTAGE
Asymptomatic	18	36
0 – ½	15	30
½ - 1	8	16
1 – 2	4	8
2 – 3	2	4
3 and above	3	6

Other than the 18 (36%) asymptomatic cases, the interval between the onset of symptoms and seeking consultation was 15 days in 15 (30%) patients, ½- 1 month in 08 (16%) and 1–2 months in 4 (8%), suggesting that most patients seek relief from symptoms quite early.



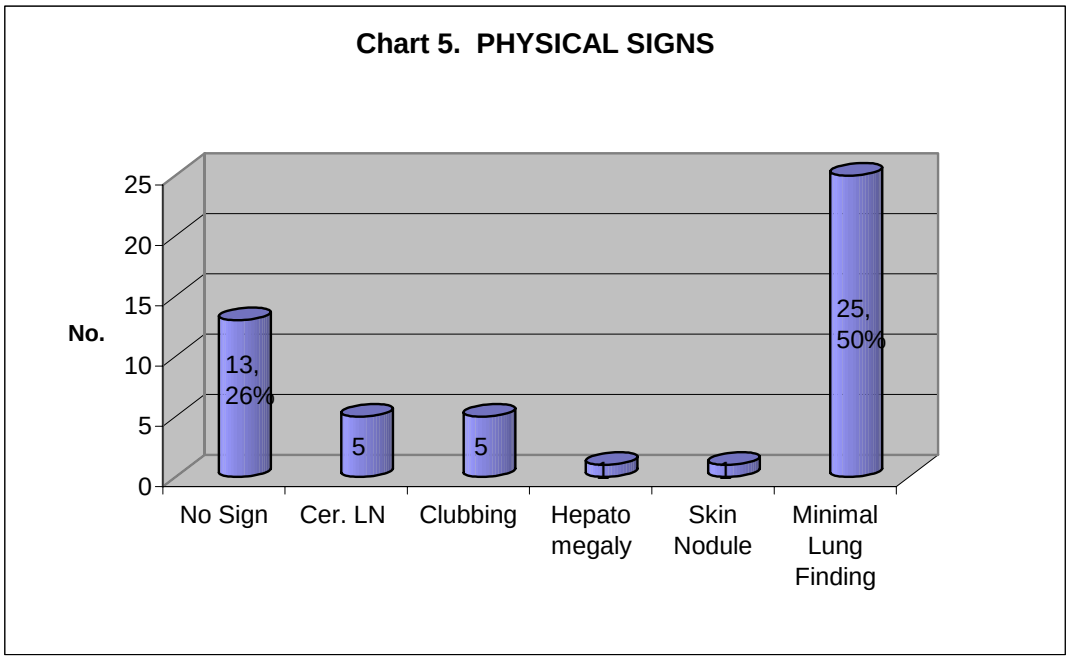


ANALYSIS OF PHYSICAL SIGNS: (Table 5, Chart 5)

13 of them (26%) did not have any general examination or systemic examination finding. 5 patients each were having cervical lymphadenopathy and clubbing. Minimal lung findings like a few occasional crackles and wheeze were present in 25 persons (50%).

Table 5

PHYSICAL SIGNS	NO. OF CASES	PERCENTAGE
No sign	13	26
Cervical lymphadenopathy	5	10
Clubbing	5	10
Hepatomegaly	1	2
Skin nodule	1	2
Minimal lung signs	25	50



FEATURES OF NODULE IN X – RAY AND CT THORAX:

DISTRIBUTION OF SOLITARY NODULE: (Table 6, Chart 6)

Table 6 **Total cases- 50**

SITE		NO. OF CASES	PERCENTAGE
Upper lobe	**right**	16	32
	left	13	26

Middle lobe	**right** **left**	2 1	4 2
Lower lobe	**right** **left**	12 6	24 12
Position	**central** **peripheral**	21 29	42 58

From the above table, it is evident that in more than half of the total cases (58%), the upper lobes were involved. The right side involvement was more i.e. in 30 out of 50 (60%) cases. Central lesions were 21 (42%), and peripheral lesions were 29 (58%).

SIZE OF OPACITY IN CHEST X – RAY: (Table7, Chart 6)

Table 7 **Total cases- 50**

SIZE IN CM.	NO. OF CASES	PERCENTAGE
1.1 – 2	2	4
2.1 – 3	9	18
3.1 – 4	14	28
4.1 – 6	25	50

MARGIN OF OPACITY: (Table 8, Chart 6)

Table 8 **Total cases- 50**

MARGIN CHARACTERISTICS	NO. OF CASES	PERCENTAGE
Smooth	27	54
Lobulated	5	10
Spiculated	18	36

THICKNESS OF CAVITY WALL IN NODULE: (Table 9, Chart 6)

Table 9 **Total cases- 50**

THICKNESS OF CAVITY	NO. OF CASES	PERCENTAGE
Non – cavitary	44	88
< 4 mm	3	6
4 – 15 mm	2	4
> 15 mm	1	2

CALCIFICATION OF NODULE: (Table 10, Chart 6)

Table 10 **Total cases- 50**

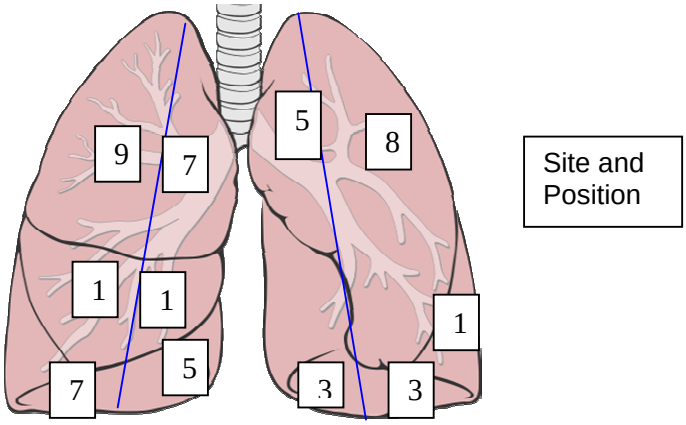
CALCIFICATION PATTERN	NO. OF CASES	PERCENTAGE
No calcification	40	80
Benign pattern	9	18
Stippled / eccentric	1	2

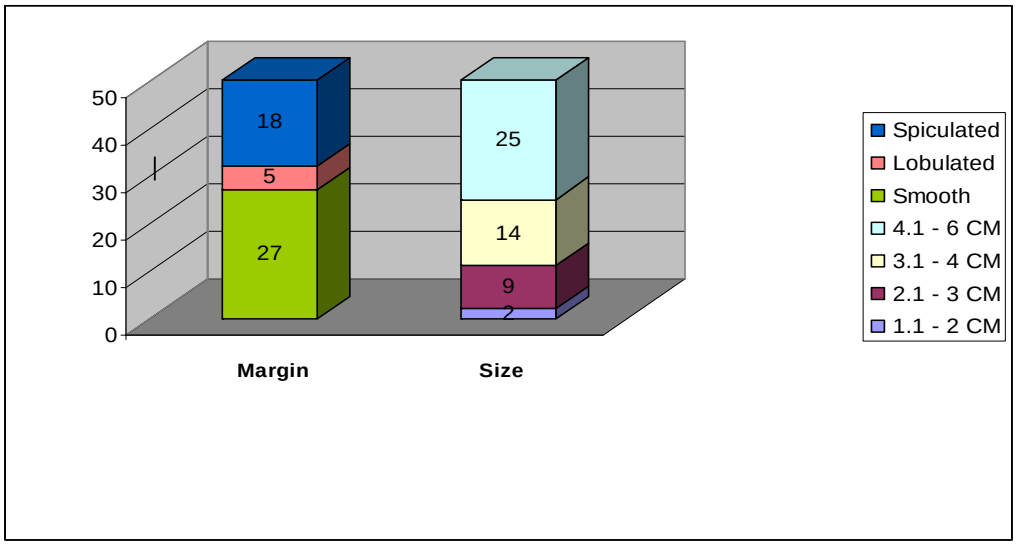
CONTRAST ENHANCEMENT: (Table 11, Chart 6)

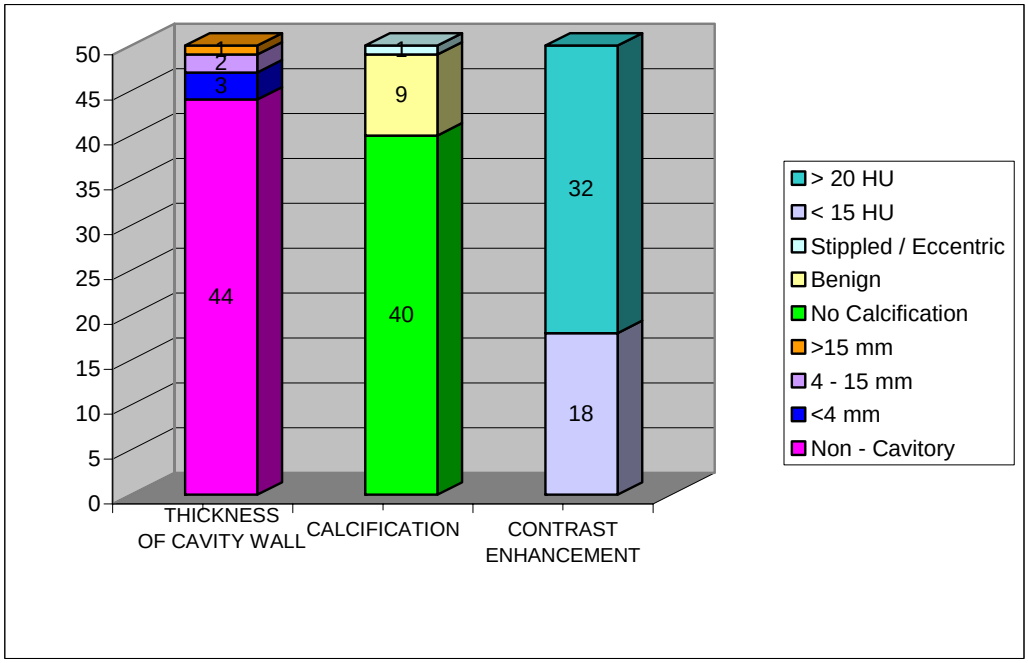
Table 11 **Total cases- 50**

CONTRAST ENHANCEMENT	NO. OF CASES	PERCENTAGE
< 15 HU	18	36
> 20 HU	32	64

Chart 6: FEATURES OF NODULE IN X – RAY AND CT THORAX







YIELD OF INVASIVE DIAGNOSTIC METHODS:

Transthoracic CT guided needle aspiration cytology / biopsy and bronchoscopy were performed in 40 cases where the diagnosis of malignancy was suggested by other diagnostic procedures and in those where other methods of diagnosis had failed or were of doubtful positivity. Transthoracic needle aspiration cytology / biopsy were done in 22 cases; bronchoscopy was performed in 18 cases and cervical lymph node aspiration cytology/ biopsy in 5 cases. Bronchoscopy was preferred in central lesions whereas transthoracic approach was undertaken in peripheral lesions. Aspiration cytology/ biopsy were done in palpable significant cervical lymph nodes.

A. Lymph node aspiration cytology/excision biopsy: (Table 12, Chart 7)

The final diagnosis was established by lymph node aspiration cytology / excision biopsy in all the 5 cases of cervical lymph nodes with efficacy rate of 100%. Sizes of the lymph nodes were 2–3 cm. Excision biopsy were done in 2 cases and in other 3 cases fine needle aspiration cytology was diagnostic. In the 2 cases that had undergone excision biopsy, fine needle aspiration cytology taken prior to that was inconclusive. All 5 cases proved to be malignant lesion, 3 were squamous cell carcinoma, 1 was small cell carcinoma and 1 was metastatic carcinoma.

Table 12. Lymph node FNAC/excision biopsy **Total no. 5**

RESULT	NO. OF CASES	PERCENTAGE
Squmous cell carcinoma	3	60
Small cell carcinoma	1	20
Metastasis	1	20

B. Transthoracic needle aspiration cytology / biopsy: (Table 13, Chart 7)

Out of the 22 CT guided aspiration cytology / biopsy of lungs, 7 cases have undergone needle aspiration and rest 15 cases, tru–cut needle biopsy. Malignant pathology was obtained in 11 (50%), inflammatory cytology in 4 (18%), tuberculosis in 3 (14%), and non-specific cytology in 2 (9%) cases. One each case of hamartoma and sarcoid nodule were also diagnosed. Among the cases of malignancy, 8 were adenocarcinoma, 2 were squamous cell carcinoma and 1 was small cell carcinoma.

Table 13 **Total no. - 22**

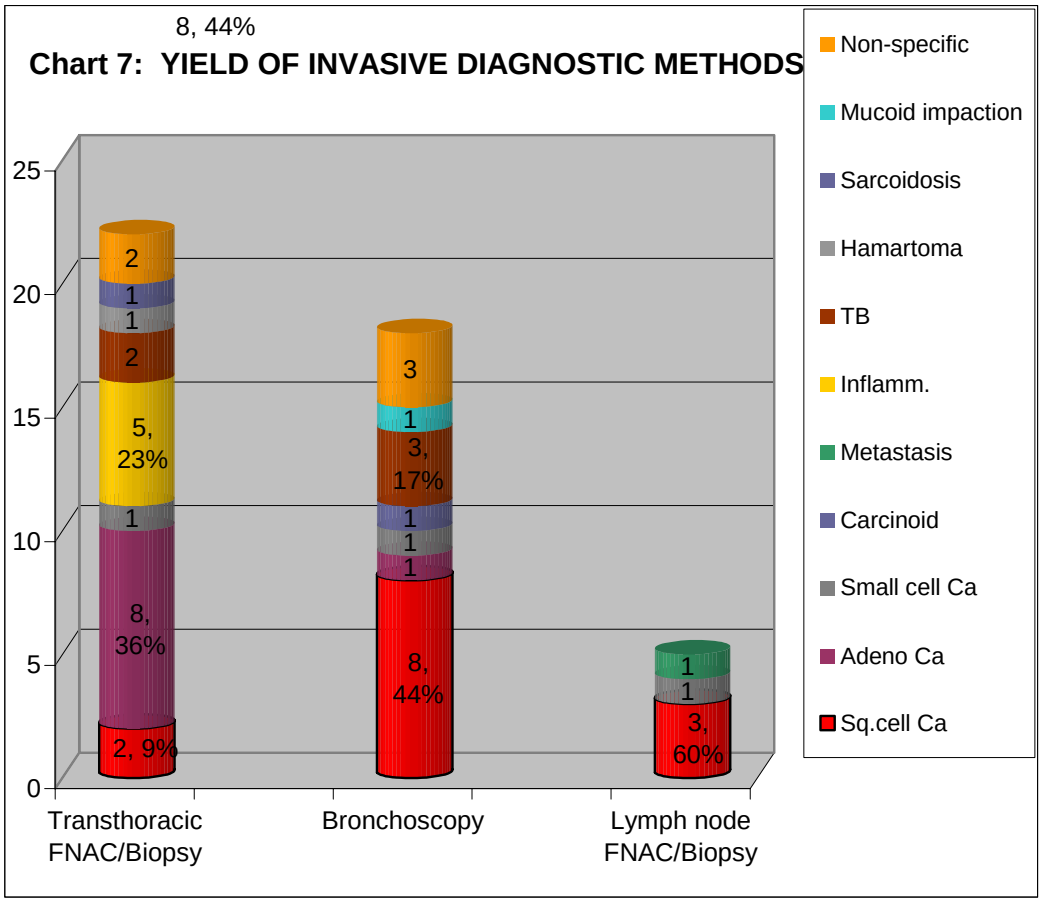
RESULT	NO. OF CASES	PERCENTAGE
Malignancy	11	50
Adenocarcinoma	8	36
Squmous cell carcinoma	2	9
Small cell carcinoma	1	4
Inflammatory cytology	5	23
Tuberculosis	2	9
Hamartoma	1	4
Sarcoidosis	1	4
Non – specific cytology	2	9

C. Fibre–optic Bronchoscopy: (Table 14, Chart 7)

Out of the 18 cases undergone bronchoscopy, 7 cases had bronchial brushing and lavage; rest 11 cases had punch biopsy taken from bronchoscopically visualised lesions. Malignant pathology was obtained in 11 (61%) and tuberculosis in 3 (17%). One person had mucoid impaction. Non–specific cytology was reported in 2 (11%) cases. Among the cases of malignancy detected, 8 were squamous cell carcinoma, one each were small cell carcinoma and adenocarcinoma – alveolar cell type. One case of carcinoid was also detected.

Table 14 **Total no. - 18**

RESULT	NO. OF CASES	PERCENTAGE
Malignancy	11	61
Squmous cell carcinoma	8	44
Adenocarcinoma	1	5
Small cell carcinoma	1	5
Carcinoid	1	5
Tuberculosis	3	17
Mucoid impaction	1	5
Non – specific cytology	3	17



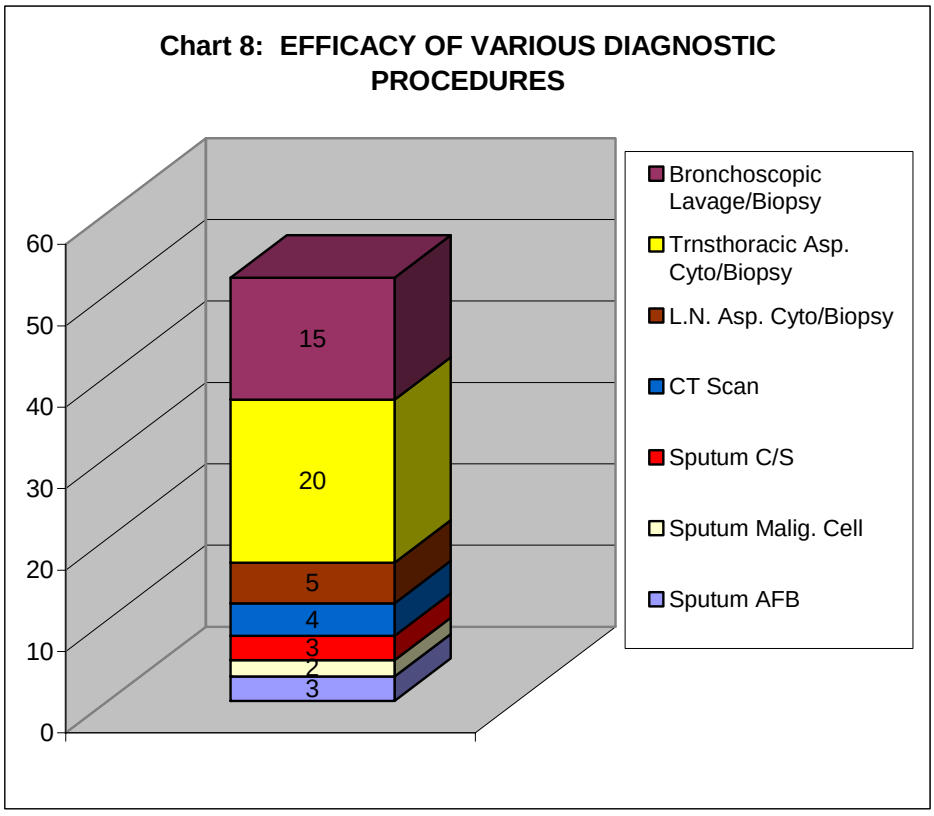
EFFICACY OF VARIOUS DIAGNOSTIC PROCEDURES:
(Table 15, Chart 8)

The efficacy of diagnosis is slightly better in transthoracic aspiration cytology / biopsy (91%), than in fibre – optic bronchoscopy and lavage / brushing / biopsy (83%); though both of them are highly efficacious (above 80%).

CT scan thorax was important to diagnose benign lesions and could diagnose pleural effusion in major fissure (pseudo –tumour), hamartoma and lung abscess.

TABLE 15. Efficacy of various diagnostic procedures

BASIS OF DIAGNOSIS	NO. OF CASES EFFECTIVE	TOTAL NO. OF CASES	PERCENTAGE
Sputum for AFB	3	50	6
Sputum for malignant cells	2	50	4
Sputum culture / sensitivity	3	50	6
Lymph node aspiration cytology / excision biopsy	5	5	100
Transthoracic aspiration cytology / biopsy	20	22	91
Fibre – optic bronchoscopy lavage / brushing / biopsy	15	18	83
CT scan with contrast **Pseudotumour** **Hamartoma** **Lung abscess**	4 2 1 1	50	8



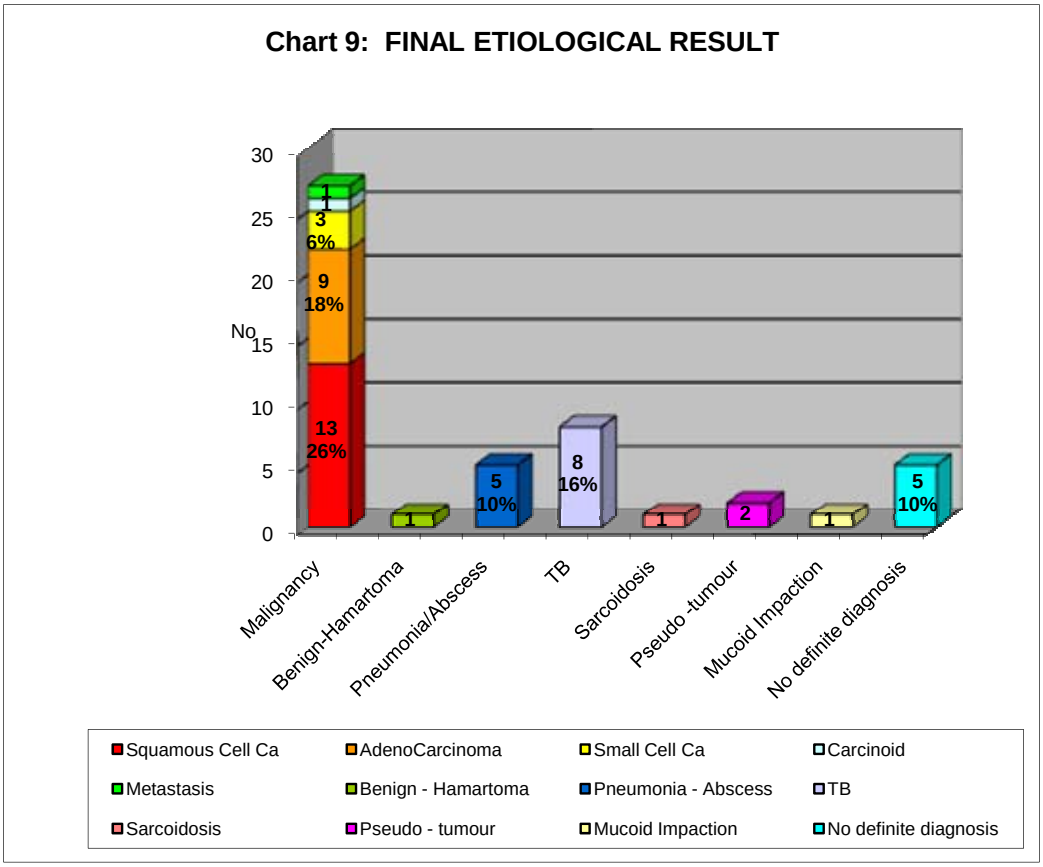
FINAL ETIOLOGICAL RESULT: (Table 16, Chart 9)

Table 16 **Total no - 50**

DIAGNOSIS	NO. OF CASES	PERCENTAGE
Malignancy	27	54
Squmous cell carcinoma	13	26
Adeno carcinoma	9	18
Small cell carcinoma	3	6
Carcinoid	1	2
Metastasis	1	2
Benign tumour – hamartoma	1	2
Pneumonia / abscess	5	10
Tuberculosis	8	16
Sarcoidosis	1	2
Pseudo –tumour	2	4
Mucoid impaction	1	2
No definite diagnosis	5 (3)	10 (6)

Out of the 5 cases (2 cases of transthoracic needle aspiration / biopsy; other 3 of bronchoscopic biopsy) of indefinite diagnosis of non–specific cytology, 2 cases were reasonably proved to be benign lesion. Both of them were 2 cm, smooth margin nodule, and were males in age group of 36–45 yrs. Both these nodule sizes remained same over 1 year period of follow–up. Other 3 cases are on follow–up currently.

Chart 9: FINAL ETIOLOGICAL RESULT



ASSOCIATION OF RISK AND PROBABILITY FACTORS WITH MALIGNANCY:

A. SMOKING : (Table 17, Chart 10)

Table 17

SMOKING (PACK – YRS)	SOLITARY NODULE ANALYSED	CASES OF MALIGNANCY	PERCENTAGE YIELD
Non – smoker	9	2	22
1 – 20	10	3	30
21 – 40	15	9	60
> 40	16	13	81

B. AGE: (Table 18, Chart 10)

Table 18

AGE GROUP (YRS.)	SOLITARY NODULE ANALYSED	CASES OF MALIGNANCY	PERCENTAGE YIELD
25 – 35	2	1	50
36 - 45	7	1	`14
46 - 55	20	10	50
56 - 65	18	13	72
66 - 76	3	2	66

C. SIZE OF NODULE: (Table 19, Chart 10)

Table 19

SIZE IN CM.	SOLITARY NODULE ANALYSED	CASES OF MALIGNANCY	PERCENTAGE YIELD
1.2 – 2	2	0	0
2.1 – 3	9	2	22
3.1 – 4	14	7	50
4.1 – 6	25	18	72

D. POSITION OF NODULE: (Table 20, Chart 10)

Table 20

POSITION	SOLITARY NODULE ANALYSED	CASES OF MALIGNANCY	PERCENTAGE YIELD
Upper + middle Lobe	32	18	56
Lower	18	9	50
Central	21	11	52
Peripheral	29	16	55

E. MARGIN OF NODULE: (Table 21, Chart 10)

Table 21

MARGIN CHARECTERISTICS	SOLITARY NODULE ANALYSED	CASES OF MALIGNANCY	PERCENTAGE YIELD
Smooth	27	9	33
Lobulated	5	1	20
Spiculated	18	17	94

F. CALCIFICATION OF NODULE: (Table 22, Chart 10)

Table 22

CALCIFICATION PATTERN	SOLITARY NODULE ANALYSED	CASES OF MALIGNANCY	PERCENTAGE YIELD
No calcification	40	26	65
Benign pattern	9	0	11
Stippled / eccentric	1	1	11

G. CAVITARY WALL THICKNESS: (Table 23, Chart 10)

Table 23

THICKNESS OF CAVITY WALL	SOLITARY NODULE ANALYSED	CASES OF MALIGNANCY	PERCENTAGE YIELD
Non – cavitary	44	25	56
< 4 mm	3	0	0
4 – 15 mm	2	1	50
> 15 mm	1	1	100

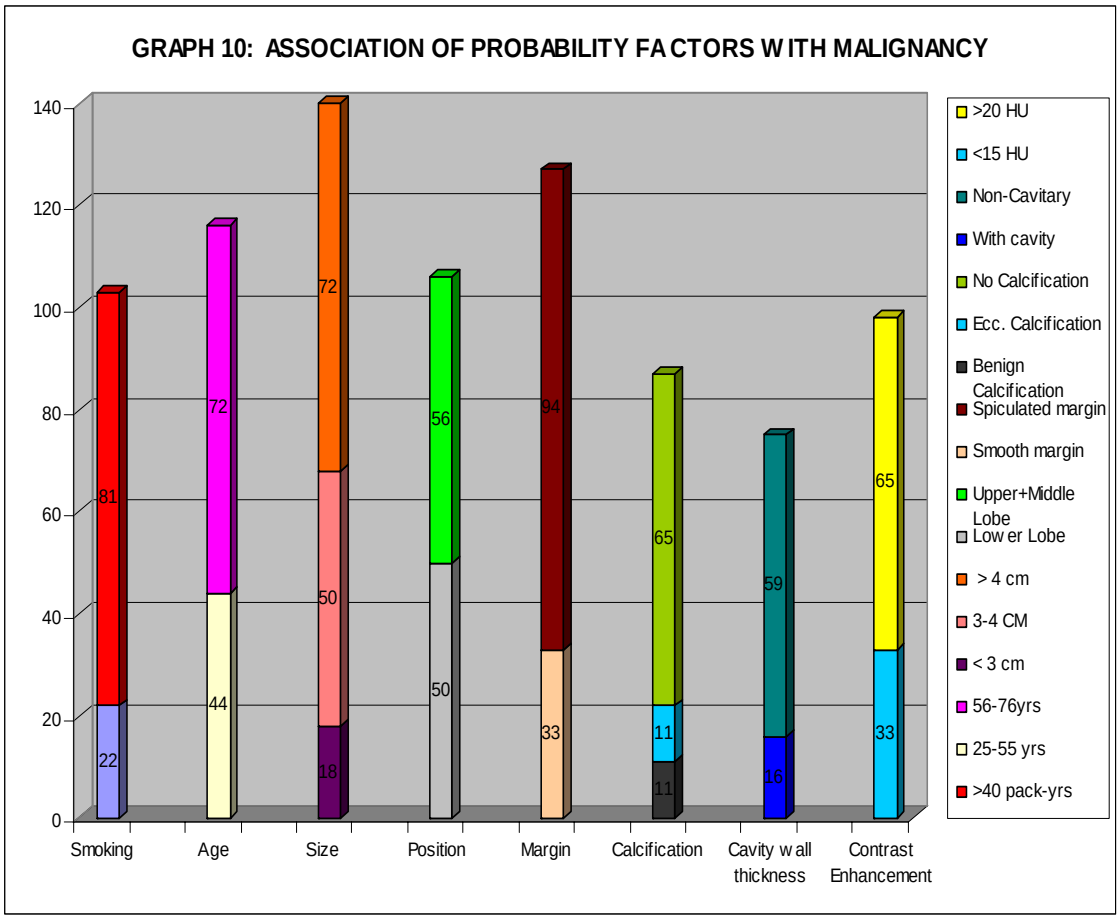
H. CONTRAST ENHANCEMENT OF NODULE: (Table 24, Chart 10)

Table 24

CONTRAST ENHANCEMENT	SOLITARY NODULE ANALYSED	CASES OF MALIGNANCY	PERCENTAGE YIELD
< 15 HU	18	6	33
> 20 HU	32	21	65

These tables show maximum association of risk and probability factors with malignancy are as follows –

Spiculated margin (94%), smoking > 40 pack–yrs (81 %), size >4 cm diameter (72%), age above 60 yrs (72%), contrast enhancement of > 20 HU (65%), non–calcified (62%) and non-cavitary lesions (56).

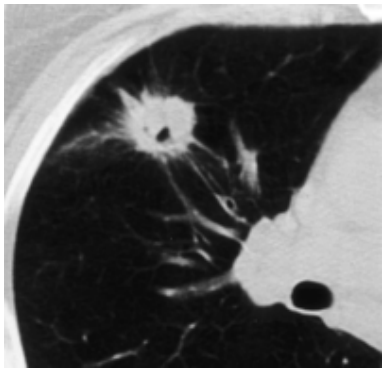


A FEW SOLITARY PULMONARY NODULES FROM THE STUDY

Solitary metastastatic tumour in a 45 year old man. Chest CT scan shows a smoothly marginated, 2-cm peripheral nodule**.**

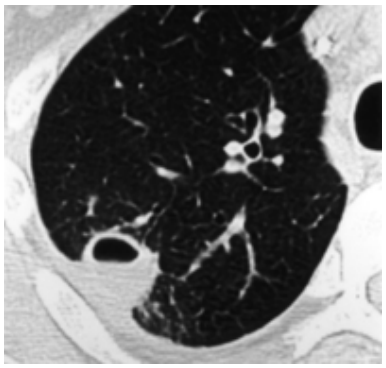
Squamous cell carcinoma in a 53 year old man. Chest CT scan of the right lung shows a lobulated and spiculated nodule in the lower lobe.

Squamous cell carcinoma in a 55 year old man. Chest CT scan shows an irregular nodule above the major fissure.

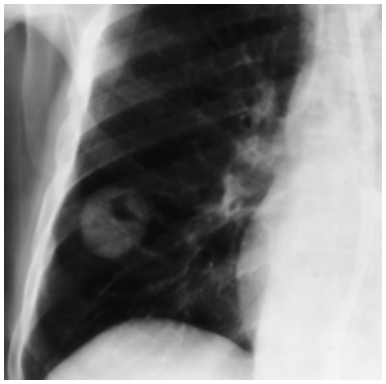


Squamous cell lung carcinoma in a 61 year old man. Close-up chest CT scan of the right lung shows a spiculated nodule with eccentric cavitation in the upper lobe.

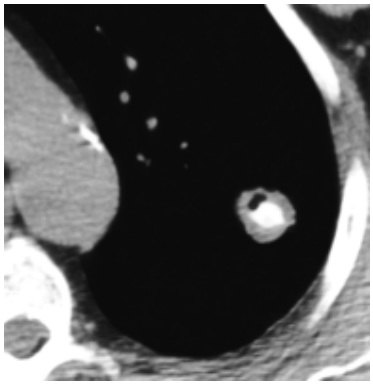
A FEW SOLITARY PULMONARY NODULES FROM THE STUDY



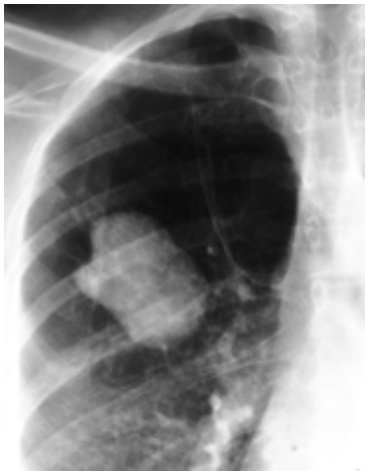
TB infection in a 45 year old woman with DM. Close-up chest CT scan of the right lung shows a thin-walled cavitary nodule**.**



Squamous cell carcinoma in a 59 year old man. Close-up x-ray of the right lung shows a smoothly marginated nodule with eccentric cavitation and thick walls in the lower lobe.



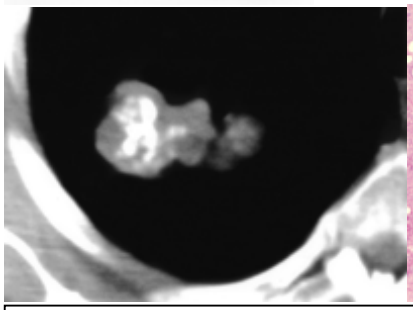
TB Granuloma in an asymptomatic 62 year old man. Close-up chest CT scan of the left lung shows a soft-tissue nodule with central calcification and eccentric cavitation in the upper lobe.

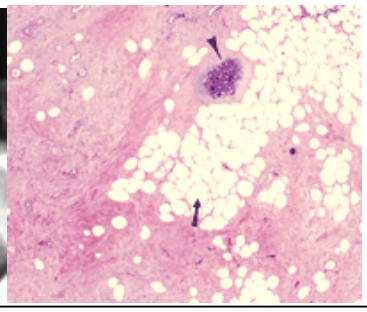


AdenoCarcinoma lung in a 65 year old man. Close-up chest X-ray of right lung shows a lobulated, sharply marginated nodule in the upper lobe. Also there is presence of emphysema and upper lobe bullae.

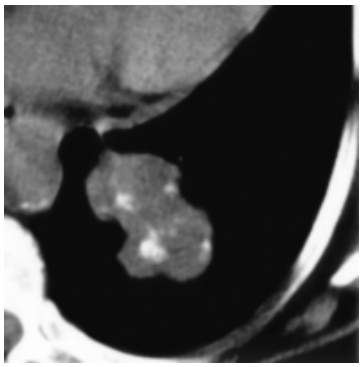
A FEW SOLITARY PULMONARY NODULES FROM THE STUDY

Round pneumonia in a 37 year old woman who presented with cough and fever. Close-up X-ray of the left lung shows a poorly marginated nodule. Because of clinical symptoms, the patient was treated for community acquired pneumonia. Follow-up x-ray performed 2 weeks later showed complete resolution of the nodular opacity.





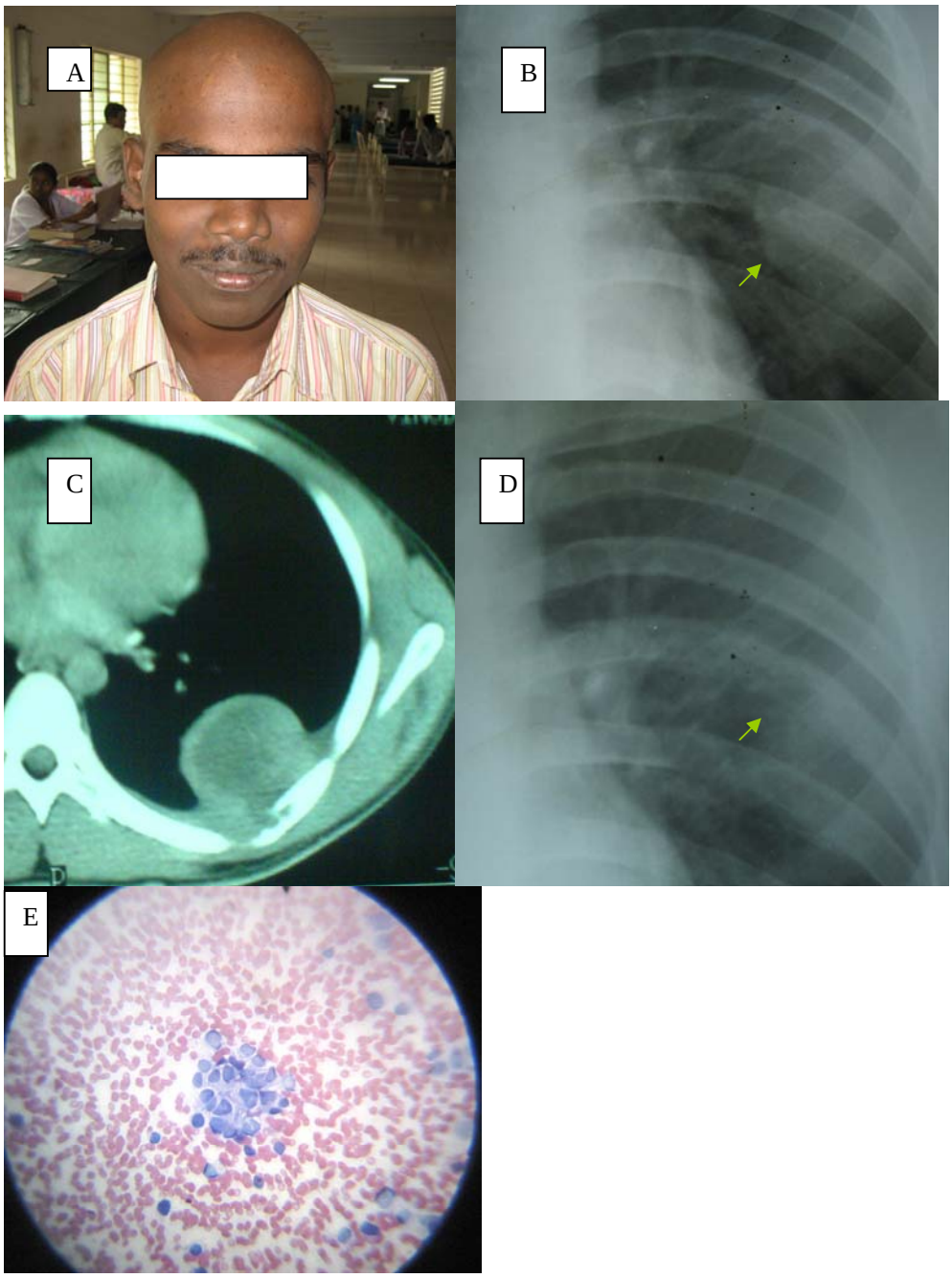
Hamartoma in a 44 year old asymptomatic man. Chest CT scan right lung shows a lobulated nodule with central popcorn like calcification. Photomicrograph confirms the presence of adipose tissue (arrow) and epithelial tissue containing an island of basophilic cartilage (arrowhead). This mixture of epithelial and mesenchymal tissue is diagnostic.



Carcinoid in a 61 year old man. CT thorax shows a lobulated lesion with scattered stippled
Calcification of
Left lower
lobe.

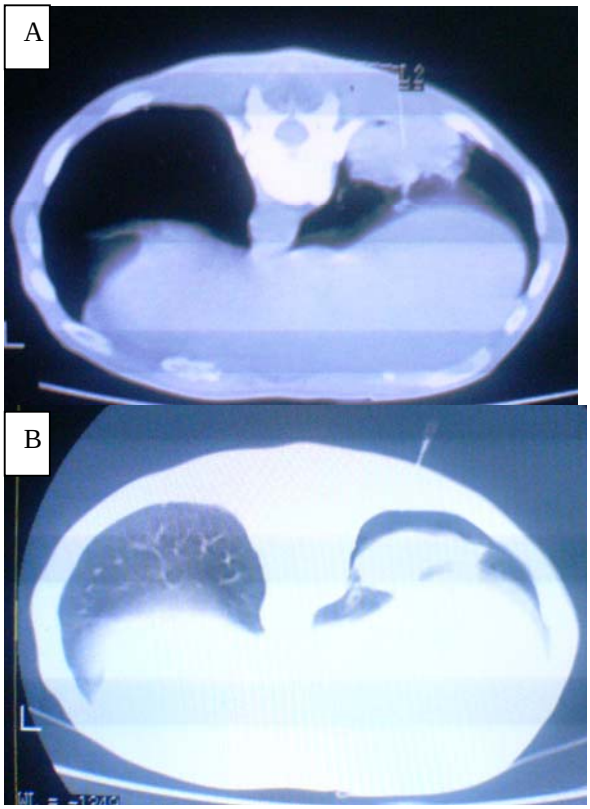
Smooth margined asymptomatic mass lesion in left lung – CT thorax proved Pseudo-tumour, Pleural effusion in transverse fissure.

A FEW SOLITARY PULMONARY NODULES FROM THE STUDY

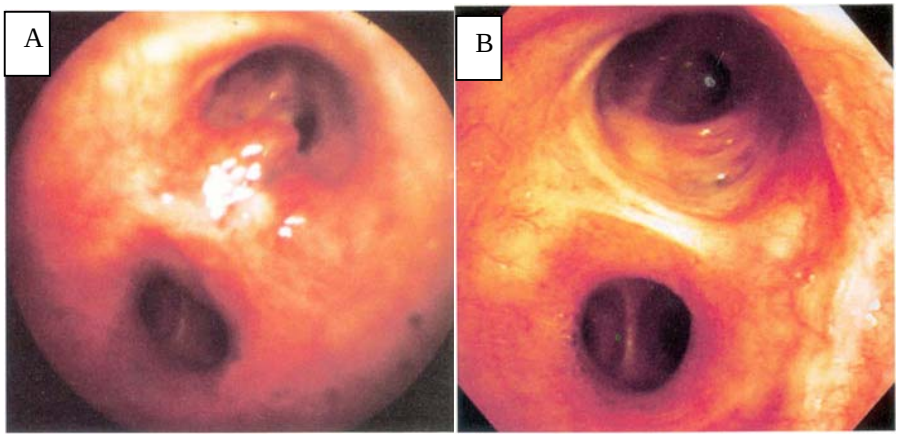


(A) 25 yrs man with small cell carcinoma (post –radiotherapy photo); having **(B)** smooth margined 3 cm peripheral nodule with **(C)** rib erosion shown in CT thorax. **(D)** Post 3 cycle of radiotherapy x-ray shows disappearance of the nodule with persistence of rib erosion. (E) Photomicrograph shows characteristic sheet of malignant cells at centre with hyperchromatic nuclei folded upon itself with scanty cytoplasm.

A FEW SOLITARY PULMONARY NODULES FROM THE STUDY



(A) CT guided fine needle aspiration being done;
(B) Showing procedural complication of minimal pneumothorax.



(A) Bronchoscopic view of tiny overhanging mass of Squmous cell carcinoma;
(B) Repeat bronchoscopy after 6 months of chemo and radiotherapy shows resolution of the lesion

DISCUSSION

Bronchogenic carcinoma is one of the visceral malignancies, which gives an early roentgen clue to its existence, though it may be asymptomatic at that stage. In our geographic region high incidence of infections, especially tuberculosis, delays the early diagnosis and treatment of malignancy. In the present series, 50 cases of Solitary Pulmonary Nodules (SPN) in chest x–ray presented to Coimbatore Medical College Hospital from January 2006 to August 2007 were studied.

Age and Sex:

In this study the average age was 53.8 years, which is quite similar to other studies. Both infective and malignant causes rise with increasing age. It is now more common to come across cases of carcinoma of lung from fifth decade onwards with increasing environmental pollution and smoking habits[66,74]. In this study, significantly, the strength of association for malignancy is 72% for persons above 60 years of age with SPN.

The youngest person in this study with Solitary Pulmonary Nodule is a 25 year old male, non–smoker and is diagnosed with small cell carcinoma. He had only vague chest pain on presentation. He is presently doing well after 3 cycle chemotherapy and the post chemotherapy x–ray shows no evidence of the SPN, but minimal rib erosion which was present at the

beginning, persists. Thus the need for an early diagnosis cannot be more stressed upon.

In this study, male patients were in overwhelming majority. Only 2 female patients were present in age 35-45 years range, both were diabetic and were diagnosed as affected with infective etiology – one with TB another with consolidation / abscess.

Risk Factors:

A. Smoking:

In this study, majority of the patients were smokers, i.e., 82%. Above 40 pack–yrs, the risk of developing malignancy is very high, as reported in various studies[58,59,62,63,64]. This is also corroborated in our study with 81% SPN being malignant in smokers above 40 pack–yrs. This strength of association is only second to spiculated margin of the SPN (94%). 9 (22%) of the smokers were also exposed to Occupational hazards. A comparative report of past Indian studies with our study is attached (Table 25).

B. Other risk factors:

9 (18%) of the SPNs were diabetic, 2 were HIV positive, 3 were having steroids for COPD and rheumatoid arthritis, 4 were old PTB cases. Majority i.e., 71% of this group had infective etiology of TB and

Pnuemonia / Abscess as their diagnosis. 5 (10%) cases did not have any apparent risk factor associated with.

Symptoms:

Symptoms, their presence or absence and their significance are difficult to evaluate in the patient having a solitary pulmonary nodule in x-ray chest. Most of the patients in the present study were asymptomatic or having vague ill-health (50%). Large majority had cough with / without expectoration (40%) and chest pain. It is comparable with previous studies of Arora et al[95] and Jindal[94] et al. The duration of symptoms before consultation was 15 days to one month in the majority of patients (52%). Thus presenting symptoms are rarely of help in establishing a diagnosis of solitary pulmonary lesion. Though haemoptysis, as reported by Gurney IW.[10] have high degree of association with malignant SPN, in our study only 2 persons had presented with haemoptysis. One had TB, the other had malignant lesion.

Signs:

No clinching physical sign could be elicitable in this series of patients, with the possible exception of cervical lyphadenopathy noted in 5 (10%) cases. One of them had a cutaneous nodule present. Minimal lung

findings like a few occasional crackles and wheeze were present in half the cases (50%). In ¼ cases (25%), there were no elicitable signs.

Features of nodule in x – ray and CT thorax:

A. Margin and Size:

The most important characteristic features of SPN have proved to be margin and size of the lesion[66,69,70,73,74]. In this study 18 (36%) of cases had spiculated margin, of which all but one case (94%) has turned out to be malignant. Sometimes only CT scan will reveal the spiculated nature of the margin in smaller lesions which deceptively may look as smooth margined in Chest x-ray[70]. Occurrence of malignancy in smooth margined lesions is also not rare as reported in many studies[71,72,78]. This study also confirmed this, i.e., 33% of smooth margined lesions were malignant.

Larger the size of the lesion, it is more probable that the lesion is malignant. The probability doubles in lesions larger than 3 cm[10,81,83]. In this series, 50% of lesions of size 3–4 cm. and 72% of lesions of size 4–6 cm. have turned out to be malignant.

B. Location:

In 64% of the cases, upper and middle lobes were involved. The right side involvement was more, i.e. in 30 out of 50 (60%) cases. Straighter

right bronchus and poor drainage of right middle lobe favours infective origin in right side lung. Central lesions were 21 (42%), and peripheral lesions were 29 (58%). Slightly higher number (56%) of malignancies has involved upper and middle lobes than the lower lobes (44%). There was no difference in incidence of malignancy found in peripheral (55%) and central lesions (52%).

C. Calcification:

There was evidence of calcification in 10 (20%) cases, 8 of which turned out to be tuberculous granulomas, 1 was hamartoma and only 1 case, in which there was stippled calcification, turned out to be malignant. Most radiologists agree that, it is not always possible to differentiate between benign and malignant nodules on the basis of size or margin [15,19,25,26,69,70]. Lillington and Caskey[24] reported that the presence of visible calcification is sufficient indication of benignity, but is not absolute proof, although the probability of cancer becomes very low.

D. Thickness of cavitary wall and contrast enhancement:

In this series, 56% of non–cavitary lesions were found to be malignant. There was only one case of thick walled cavity (> 15 mm), which was finally diagnosed as malignancy. Thin walled cavities, if present, usually

indicate infective / TB etiology. All 5 of the thin walled cavities within the nodule, in this study were non malignant.

Contrast enhancement of the nodule in CT thorax of > 20 HU is an important indicator for higher probability of malignancy[10]. Infective conditions with increased vascularity also causes contrast enhancement. In this study, 65% of the contrast enhancing lesions were found to be malignant.

E. Growth rate:

Comparison of previous chest radiographs of the patient allows assessment of the growth rate. Malignant growth rate with doubling time of 20–400 days is very important indicator for higher probability of malignancy[10,11,12]. In this series, for 5 patients of SPN of 2 cm smooth margined nodule, no definite diagnosis could be arrived at after trans - thoracic needle aspiration and bronchoscopic biopsy due to non–specific cytology. Over one year of follow–up, the nodule sizes had not increased. This was sufficient to indicate pathology of benign origin.

Yield of diagnostic methods:

A. Fine needle aspiration cytology / biopsy of lymph node

Fine needle aspiration cytology and excision biopsy plays a prominent role for tissue diagnosis, if any palpable cervical or axillary lymph node

is available. In this study, it was proved convincingly by having diagnosed 5 cases of malignancy out of the same number of cervical lymph nodes biopsied. Yield of excision biopsy is better than fine needle aspiration cytology. Fine needle aspiration cytology was inconclusive in 2 cases, which were definitely proven malignant after excision biopsy done immediately later. The cases were as follows - 3 Squamous Cell Carcinoma, 1 Small Cell Carcinoma and 1 Metastatic Carcinoma.

B. Transthoracic CT guided aspiration cytology / biopsy

VS

Fibre–optic Bronchoscopy and lavage / brushing / biopsy

The efficacy of diagnosis is slightly better with transthoracic aspiration cytology / biopsy (91%), than with fibre–optic bronchoscopy and lavage / brushing / biopsy (83%). However, both of them are highly efficacious (above 80%) in properly selected patients.

Transthoracic approach is favoured in peripheral lesions whereas for central lesions bronchoscopy is more favoured. This is because; only upto fourth order of bronchial divisions could be entered via fibre-optic bronchoscopy (Kovant et al[84]). Another drawback of usage of bronchoscopy is only in intra – bronchial pathology, biopsy or bronchial brushing / lavage under direct vision will be helpful. Only large lesions

are expected to be affecting the bronchial mucosa sufficiently for the biopsy or lavage to be diagnostic. When the lesion is < 2 cm, the yield is 20-40%, but increases to 60-80% when the lesion is > 3 cm[77]. Kavale et al[85] reported increased yield in non – visualised lesions when trans – bronchial lung biopsy is done under fluoroscopic guidance. Also Cortese et al[79] reported that the diagnostic yield decreases when lesion is less than 1.5 cm from the hilum. In this series of patients also, bronchoscopy was slightly less efficacious. All the patients selected for bronchoscopy were having larger lesions of > 3 cm and occupying central 1/3 of the lungs in X- ray. This result of 83% positivity is comparable to earlier Indian Studies where positivity results range from 45 – 88 %. As central lesions were more focused here, 44% cases of SPN, who underwent bronchoscopy were detected to have squamous cell carcinoma.

CT guided FNAC of lungs has been increasingly used in recent years, because of its accuracy, safety, quickness and cost effectiveness. The diagnostic yield by percutaneous needle biopsy was 91%, of which 50% were malignant. This also compares well with literature where the yield has ranged between 50 – 96%[65,67,68]. The yield depends on size and position of the lesion. If the lesion is < 2cm, yield is 85%, for 2- 6 cm 96%, but in lesion > 6 cm, it is reduced to 78% (Henschke et al[82]). The yield in smaller lesion is essentially good because of less secondary inflammation. In larger lesions, there is necrosis, which hampers correct

tissue diagnosis. The cutting needle tru cut biopsy is more useful than fine needle aspiration cytology in benign lesions and in metastatic tumour (Henschke et al[82]). This is because specimen obtained for histopathological study is better. But benign lesions like cysts and abscesses can only be diagnosed by fine needle aspiration cytology. As peripheral lesions are more important here, 36% of SPN, who underwent transthoracic aspiration / biopsy were found to be adenocarcinoma.

Percutaneous needle biopsy was associated in all series with significant evidence of pneumothorax of 10 – 44%[65]. In this study it was 6% with none requiring chest tube drainage.

Final etiological diagnosis:

54% of cases i.e. 27 of the SPNs were found to be malignant in this study. The incidence of Malignancy found in this study was slightly higher than the average reported in earlier Indian studies [87,88,89,90,91,92,93,94,95,96,97,98,99]. Out of the malignancies, squamous cell carcinomas were of 48% (13 in no.) whereas adenocarcinoma was of 33% (9 in no.) only. The higher incidence of squamous cell carcinoma is probably due to inordinately high number of heavy smokers (82%) in the study population and in India squamous cell carcinoma incidence is higher as reported in earlier

referred Indian studies. 11% (3 in no.) were small cell carcinoma, and 1 each was carcinoid, metastatic lesion and benign tumour of hamartoma.

26% of total cases of SPNs were of infective origin, of which 16% were TB and 10% were Pnumonia / Lung Abscess. 2 cases of Pseudo – tumour of fluid in transverse fissure were detected. There was one case of sarcoidosis and another case of mucoid impaction, which cleared after bronchoscopic lavage.

Out of 5 cases of non – specific cytology, 2 cases were reasonably proved to be benign lesion. Both of them were males in the age group of 36 – 45 yrs, who had 2 cm smooth margined nodule, and both these nodules remained same over 1 year period of follow –up. Other 3 cases are on follow – up currently.

Prognosis of Malignancies in present study:

Out of the 27 cases of malignancies presented as SPN, 5 (18%) cases were already having cervical lymphadenopathy, i.e. stage III B disease with reported poor prognosis of 5 year survival rate <5%[58,62,63]. 1 case (4%) of small cell carcinoma was having liver metastasis on presentation. This stage IV disease has reported 5 year survival rate of <1%[58,62,63]. One of the stage III B disease and the patient in stage IV at diagnosis has died within one year of diagnosis.

Among the remaining 21 cases, only 2 (7%) cases were in stage I A disease (with 5 year survival rate of 70-80%[58,62,63]), one was small cell carcinoma and another was adenocarcinoma. Both of them were peripheral lesion. Being diagnosed early, with treatment, both of them are faring well. Another 4 (15%) cases were in stage I B disease bearing good prognosis (5 year survival rate of 57%[58,62,63]). Rest 17 (62%) cases were stage II and III A diseases, with intermediately poor prognosis (5 year survival rate of 25 – 50%[58,62,63]).

In this study only 22% of cases could be diagnosed sufficiently early to have good 5 year survival rate with treatment. Most of the cases of malignancy (88%) even in state of Solitary Pulmonary Nodule were detected only in fairly advanced stages. This is in accordance with other previous studies. This is for reasons noted below[58,62,63]-

- Signs and symptoms are inconclusive
- Significant number remain asymptomatic in early stage
- Nature of bronchogenic carcinoma being highly malignant with local and distant lymph node spread and metastasis happening much early in disease process.

SUMMARY

- 54% of Solitary Pulmonary Nodule in the study was malignant. 26% cases were of infective origin – tuberculosis and pneumonia / lung abscess. 14% cases were benign and 6% were indeterminate lesion.
- 48% of the malignancies were squamous cell carcinoma, 33% were adenocarcinoma and 10% were small cell carcinoma.
- Commonest malignancy in SPN was squamous cell carcinoma. Inordinately high number of smokers in study population probably predisposed to higher incidence of squamous cell carcinoma.
- Symptoms and signs were not conclusive. 50% cases were asymptomatic or had vague ill-health. 40% had cough with or without sputum. Minimal non-specific lung signs (50%) or no elicitable physical sign (25%) were predominant findings.
- 22% cases only could be diagnosed early enough for a favourable treatment response.
- Exclusively males were found to have malignancy in SPN, though female sample size was very low (no. 2) in this study.
- 72% of SPNs above 60 yrs of age were malignant. But even at age 25 yrs, Small Cell Carcinoma has developed.

- 82% of study population were smokers, 81% of > 40 pack yrs smokers had developed malignancy.
- 18% of SPNs were diabetics and were mostly having infective pathology.
- Most important characteristic feature of SPN is margin and size of the lesion in x – ray.
- 94% of spiculated margin and 72% of size >4 cm diameter nodules were malignant. 88% of <3cm nodules were benign/infective origin
- 65% of nodules with contrast enhancement of > 20 HU in CT were malignant.
- 2 cases of indeterminate pathology could be diagnosed of benign pathology only on basis of benign pattern of doubling time.
- Both transthoracic aspiration cytology / biopsy and fibre – optic bronchoscopy and lavage / brushing / biopsy were important diagnostic tools in carefully selected patients with yield of > 80%. Overall, transthoracic aspiration cytology / biopsy were slightly more efficacious as a diagnostic measure.
- Fine needle aspiration cytology / biopsy of lymph nodes were conclusive in palpable lymph nodes.

CONCLUSION

The approach to a patient with a pulmonary nodule should be based on an estimate of the probability of cancer, determined according to the size of the nodule, the presence or absence of a history of smoking, the patient's age, and characteristics of the nodule's margins and contrast enhancement on CT imaging.

As 54% of the Solitary pulmonary Nodules (SPN) was malignant in this study, high index of suspicion is the key to early diagnosis in view of inconclusive symptoms and signs.

Low probability of cancer nodules need to be periodically reviewed; whereas possible malignant and indeterminate nodules need to be further investigated.

Transthoracic CT guided fine needle aspiration/biopsy was slightly superior tool than bronchoscopy and biopsy for diagnosis. Fine needle aspiration/biopsy of significant palpable lymph nodes was very effective too.

Though early diagnosis of malignancy in SPN was a goal, only 22% could be diagnosed early enough for a favourable treatment response, suggesting prevention by smoking recession is very important.

REFERENCES

1. Tuddenham, WI **Glossary of terms for thoracic radiology: recommendations of the Nomenclature Committee of the Fleischner Society.** *Am J Roentgenol* 1996,43,509-517

2. Leef, JL, 3rd, Klein, IS **The solitary pulmonary nodule**. *Radiol Clin North Am* 2002;40,123-143

3. Abeloff, MD, Annitage, IO, Lichter, AS, et al *Clinical oncology* 3rd ed 2005,1398-1464

4. Mountain, CF **Revisions in the international system for staging lung cancer**. *Chest* 1997;111,1710-1717

5. Yankelvitz, DF, Hensche, **Lung cancer: small solitary pulmonary nodules**. *Radiol Clin North Am* 2004;38,1-9

6. Greenlee, RT, Hill-Harmon, MB, Murray, T, et al **Cancer statistics, 2001**. *CA Cancer J Clin* 2001;51,15-36

7. Jemal, A, Murray, T, Thun, LA **Cancer statistics, 2002**. *CA Cancer J Clin* 2002;52,23-47

8. Swanson, SI, Iaklitsch, MT, Mentzer, SI, et al **Management of the solitary pulmonary nodule: role of thoracoscopy in diagnosis and therapy**. *Chest* 1999;116,523S-524S

9. Swenson, SJ, Silverstein, MD, Ilstrup, DM, et al **The probability of malignancy in solitary pulmonary nodules: application to small radiologically indeterminate nodules**. *Arch Intern Med* 1997;57,849-855

10. Gurney, IW **Determining the likelihood of malignancy in solitary pulmonary nodules with Bayesian analysis: Part I. Theory & Part II Practical**. *Radiology* 1993;186,405-413, 415-422

11. Henske, CT, Yankelevitz, DF, Mateesscu, I, et al **Neural networks for the analysis of small pulmonary nodules**. *Clin Imaging* 1997;21,390-399

12. Nakamura, K, Yoshida, H, Engelmann, R, et al **Computerized analysis of the likelihood of malignancy in solitary pulmonary with use of artificial neural networks**. *Radiology* 2000;214,823-830

13. Lillington, GA **Management of solitary pulmonary nodules: how to decide when resection is required**. *Postgrad Med* 1997;101,145-150

14. Potchen, El, Bisesi, MA **When is it malpractice to miss lung cancer on chest radiographs?** *Radiology* 2000;175,29-32

15. Stitik, FP, Tockrnan, MS **Radiologic screening in the early detection of lung cancer**. *Radiol Clin North Am* 1998;16,347-366

16. Heenan, RT, Flehinger, BJ, Melamed, MR, et al **Non-small cell lung cancer: results of the New York screening program**. *Radiology* 2004;151,289-293

17. Muhm, JR, Miller, WE, Fontana, RS, et al **Lung cancer detected during a screening program using 4-month chest radiographs**. *Radiology* 2003;143,609-615

18. Guiss, LW, Kuenstler, A **retrospective review of survey photofluorograms of persons with lung cancer**. *Cancer* 1999;13,91-95

19. Quekel, LO, Kessels, AG, Goei, R, et al **Miss rate of lung cancer on the chest radiograph in clinical practice.** *Chest* 1999;115,720-732

20. Good, CA **Management of patient with solitary mass in lung**. *Chic Med Soc Bull* 1993;55,893-896

21. Good, CA, Wilson, TW **The solitary circumscribed pulmonary nodule**. *JAMA* 1987;166,210-215

22. Berger, WG, Erly, WK, Krupinski, EA, et al **The solitary pulmonary nodule on chest radiography: can we really tell if the nodule is calcified?** *AJR Am J Roentgenol* 1999;176,201-204

23. Fraser, RG, Pare, JA *Diagnosis of diseases of the chest. 5th ed.* 2004;Vol 2.,1327-1699.

24. Lillington, GA, Caskey, **Cl. Evaluation and management of solitary multiple pulmonary nodules.** *Clin Chest Med* 1993;14,111-119

25. Zwirewich, CV, Vedal, S, Miller, RR, et al **Solitary pulmonary nodule: high resolution CT and radiologic-pathologic correlation**. *Radiology* 2001;179,469-481

26. Zerhouni, EA, Stilik, FP, Siegelman, SS, et al **CT of the pulmonary nodule: a cooperative study**. *Radiology* 1996;160,319-327

27. White, P, Adams, H, Crane, M, et al **Preoperative staging of carcinoma of the bronchus: can computed tomographic scanning reliably identify stage II tumours.** *Thorax* 1994;49,951-957

28. Shaffer, K **Radiologic evaluation in lung cancer: diagnosis and staging**. *Chest* 1997;112,235S-238S

29. Shea, J, Lillington, GA **Preoperative staging of lung cancer**. *West J Med* 1994;161,508-509

30. Rolston, KV, Rodriguez, S, Dholakia, N, et al **Pulmonary infections mimicking cancer: a retrospective three year review.** *Support Care Cancer* 1997;5,590-593

31. Shure, D, Fedullo, PF **Transbronchial needle aspiration of peripheral masses.** *Am Rev Respir Dis* 1983;728,1090-1092

32. Woodring, JH, Fried, AM **Significance of wall thickness in solitary cavities of the lung: a follow-up study**. *AJR Am J Roentgenol* 1993;140,473-474

33. Swenson, SI, Brown, LR, Colby, TV, et al **Lung nodule enhancement at CT: prospective findings**. *Radiology* 1996;201,447-455

34. Gould, MK, Maclean, CC, Kuschner, WG, et al **Accuracy of positron emission tomography for diagnosis of pulmonary nodules and mass lesions: a meta-analysis**. *JAMA* 2001;285,914-924

35. Seely, IM, Mayo, IR, Miller, RR, et al **T1 lung cancer: prevalence of mediastinal nodal metastases and diagnostic accuracy of CT**. *Radiology* 1993;186,129-132

36. Decker, GL, Whitlock, WL, Schaefer, PS, et al **The impact of thoracic computed tomography in clinically staged T1N0M0 chest lesions**. *Arch Intern Med* 1990;150,557-559

37. Goldsmith, SI, Kostakoglu, L **Nuclear medicine imaging of lung cancer**. *Radiol Clin North Am* 2000;38,511-524

38. Dewan N, Shehan C, Reeb S. **Likelihood of malignancy in a solitary pulmonary nodule. A description of the possible role of SPECT scanning in the evaluation of the solitary pulmonary nodule.** *Chest* 1997; 112: 416-422

39. Weisbrod, GL **Transthoracic needle biopsy**. *World J Surg* 1993;17,705-711

40. Sanders, C **Transthoracic needle aspiration.** *Clin Chest Med* 1992;13,11-16

41. Lacasse, Y, Wong, E, Guyatt, GH, et al **Transthoracic needle aspiration biopsy for the diagnosis of localized pulmonary lesions: a meta-analysis**. *Thorax* 1999;54,884-893

42. Doiselle, PM, Shepard, IO, Mark, EL **Routine addition of an automated biopsy device to fine-needle aspiration of the lung: a prospective assessment**. *AJR Am J Roentgenol* 1997;169,661-666

43. Stewart, CI, Stewart, IS **Immediate assessment of fine needle aspiration cytology of the lung.** *J Clin Pathol* 1998;49,839-843

44. Murphy, JM, Gleeson, FV, Flower, CD **Percutaneous needle biopsy of the lung and its impact on patient management**. *World J Surg* 2004;25,373-380

45. American Thoracic Society/European Respiratory Society. **Pretreatment evaluation of non-small-cell lung cancer.** *Am J Respir Crit Care Med* 2005,117;156,320-332

46. Arroliga, AC, Matthay, RA **The role of bronchoscopy in lung cancer**. *Clin Chest Med* 2003;14,87-98

47. Stringfield, JT, Markowitz, DJ, Bentz, RR, et al **The effect of tumor size and location on diagnosis by fiberoptic bronchoscopy**. *Chest* 1997;72,474-476

48. Baaklini, WA, Reinoso, MA, Gorin, AB, et al **Diagnostic yield of fiberoptic bronchoscopy in evaluating solitary pulmonary nodules**. *Chest* 2000;117,1049-1054

49. Torrington, KG, Kern, JD **The utility of fiberoptic bronchoscopy in the evaluation of solitary pulmonary nodules**. *Chest* 2003;104,1021-1024

50. Thaete, FL, Peterson, MS, Plunkett, MB, et al **Computed tomography: guided wire localization of pulmonary lesions before thoracoscopic lung resection: results in 101 cases**. *J Thorac Imaging* 1999;14,90-98

51. Mullan, BF, Stanford, W, Barnhart, W, et al **Lung nodules: improved CT-guided localization**. *Radiology* 1999;211,561-565

52. Suzuki, K, Nagai, K, Yoshida, J, et al **Video-assisted thoracoscopic surgery for small indeterminate pulmonary nodules**. *Chest* 1999;115,563-568

53. Martini, N, Ginsberg, RJ **Treatment of stage I and stage II disease.** Aisner, R Arriga, R Green, Net al eds. *The comprehensive textbook of thoracic oncology* 1996,338-350

54. Warren, WH, Faber, LP **Segmentectomy vs lobectomy in patients with stage I pulmonary carcinoma.** *J Thorac Cardiovasc Surg* 1994;107,1087-1093

55. Ginsberg, RJ, Rubinstein, LV **Randomized trial of lobectomy vs limited resection for T1N0 non-small cell lung cancer: Lung Cancer Study Group**. *Ann Thorac Surg* 1995;57,615-622

56. American College of Chest Physicians: **Diagnosis and management of lung cancer: ACCP evidence based guidelines.** *Chest*, 2003,123:1S,

57. Awai K, Murao K, Ozawa A, et al: **Pulmonary nodules at chest CT: effect of computer-aided diagnosis on radiologists' detection performance**. *Radiology* 2004 Feb; 230(2): 347-52

58. Fein AM, Feinsilver SH, Ares CA. **The solitary pulmonary nodule: a systemic approach**., Fishman AP., Fishman's pulmonary diseases and disorders. 4th ed. Vol. 2. 2004:110(2):1727-37.

59. Gerard M. Turino; York E. Miller: **Pulmonary Neoplasm**. Goldman: *Cecil textbook of Medicine*, 21st Edn. 2004, pp 379-455

60. Goldsmith SJ, Kostakoglu L: **Role of nuclear medicine in the evaluation of the solitary pulmonary nodule**. *Semin Ultrasound CT MR* 2000 Apr; 21(2): 129-38

61. Jain P, Kathawalla SA, Arroliga AC: **Managing solitary pulmonary nodules**. *Cleve Clin J Med* 2004 Jun; 65(6): 315-26.

62. John D. Minna,**: Neoplasms of the Lung**, *Harrison's Principle of Internal Medicine* ,vol I, 506, 16th Edn. 2005

63. John. F. Murray & J.A. Nadel,**: Solitary pulmonary nodule**, *Text Book of Respiratory Medicine* 1578, 5th Edn. 2004.

64. Karnath B: **Smoking cessation**. *Am J Medicine* 112:399, 2002

65. Klein JS, Zarka MA: **Transthoracic needle biopsy**. *Radiol Clin North Am* 2000 Mar; 38(2): 235-66, vii

66. Ost D, Fein A: **Evaluation and management of the solitary pulmonary nodule**. *Am J Respir Crit Care Med* 2000 Sep; 162(3 Pt 1): 782-7

67. Poulos A: **CT and nodules revisited**. *Postgrad Med* 2003 Dec; 114(6): 8; author reply 8

68. Richard A. Bordow etal. : **Solitary Pulmonary Nodule, Manual of Clin. Problem**, *Pulm Med*. 4th Edn. 478,1996

69. Shaham D, Guralnik L: **The solitary pulmonary nodule: radiologic considerations**. *Semin Ultrasound CT MR* 2000 Apr; 21(2): 97-115

70. Siegelman SS, Zerhouni EA, Leo FP, et al: **CT of the solitary pulmonary nodule**. *AJR Am J Roentgenol* 1990 Jul; 135(1): 1-13

71. **Special issue dealing with all aspects of the diagnosis and treatment of small cell lung cancer**. *Semin. Oncol* 30:3, 2003

72. Libby D, Henschke C, Yankelevitz D. **The solitary pulmonary nodule: Update** 2005. *JAMA* 2005; 99: 491-496.

73. David Ost, **The Solitary Pulmonary Nodule**, *NEJM* 2003, vol 348, 2535-2542

74. Tan et al, **The Solitary Pulmonary Nodule**, *Chest.* 2003;123:89S-96S

75. Atrreanu R., **Invasive procedures in positive diagnosis of SPN**, *Pneumologia* 2004, 53(4); 198-200

76. Schiaron F., **Multidisciplinary management of SPN**, *Radiological Medicine(Torino)*, 2005, sep;149-155

77. Chajed P. N., **Combining bronchoscopy and PET for diagnosis of SPN ≤3 cm**, *Chest* 2005, 128(5)3558-3564

78. Yilmezbayhen A., **Diagnostic approach to SPN**, *Toberb Toraks*, 2005:53(3);307-18

79. Cortese DA, McDougall JC. **Bronchoscopic biopsy and brushing with fluoroscopic guidance in nodular metastatic lung cancer**. *Chest* 1981;79:610-1

80. Holin SN, Dwork RE, Glaser S, Rickli AE, Stocklen JB. **Solitary pulmonary nodules found in a community-wide chest roentgenographic survey**. *Am Tuberc Pulm Dis* 1959;79:427-39.

81. Swensen SJ, Silverstein MD, Edell ES, et al. **Solitary pulmonary nodules: clinical prediction model versus physicians**. *Mayo Clin Proc* 1999;74:319-29.

82. Henschke CI, Davis SD, Auh Y, et al. **Detection of bronchial abnormalities: comparison of CT and bronchoscopy.** *J Comput Assist Tomogr* 1987;11:432-5.

83. Gambhir SS, Shepherd JE, Shah BD, et al. **Analytical decision model for the costeffective management of solitary pulmonary nodules**. *J Clin Oncol* 1998;16:2113-25.

84. Kovant et al, **Bronchoscopic evaluation of mass lesions: a review**, *Chest*, 1999, 54:745-752

85. Kavale et al, **Bronchoscopic biopsies and BAL**, *Cl digest of Surg. Clin. N. Am.*, 1996, 6:205-222.

86. M. K. Misra, **Patterns of TB lesions in resected specimen of lungs**, *Indian Journal of TB*, 1996, 761:31

87. Sahu G. N., **Etiology of Solitary Pulmonary Nodule**; *Ind J. TB*, 1999, 46, 189

88. Viswanathan et al, **Lung cancer in India**, *Indian J Chest Dis Allied Sci* 2004; 46 : 269-281

89. Shankar PS. **Bronchogenic carcinoma**. *Indian J Chest Dis* 1967; 9 : 161-64.

90. Nagrath SP, Hazra DK, Lahiri B, Kishore B, Kumar R. **Primary carcinoma of the lung, Clinicopathological study of 35 cases**. *Indian J Chest Dis* 1970; 12 : 15-24.

91. Jha VK, Roy DC, Ravindran P. **Bronchogenic carcinoma: A clinicopathological study**. *Indian J Chest Dis* 1972; 14 : 78-85.

92. Narang RK, Dubey AL, Gupta MC, Raju S. **Primary bronchial carcinoma: A clinical study**. *Indian J Chest Dis Allied Sci* 1977; 19 : 120-23.

93. Malhotra V, Malik R, Beohar PC, Gondal R, Khanna SK, Narayanan PS. **Tumours of the lung : Histomorphological study**. *Indian J Chest Dis Allied Sci* 1986; 28 : 28-40.

94. Jindal SK, Malik SK, Malik AK, Singh K, Gujral JS, Sodhi JS. **Bronchogenic carcinoma: A review of 150 cases**. *Indian J Chest Dis Allied Sci* 1979; 21 : 59-64.

95. Arora VK, Seetharaman ML, Ramkumar S, *et al.* **Bronchogenic carcinoma: Clinicopathological pattern in south Indian population**. *Lung India* 1990; **7** : 133-38

99. Rajasekaran S, Manickam TG, Vasanthan PJ, *et al.* **Pattern of primary lung cancer: A Madras study.** *Lung India* 1993; 9 : 7-11.

PROFORMA

CLINICAL STUDY

SOLITARY PULMONARY NODULE

1. Serial No.:
2. Patient's Name: Age: Sex:
3. I.P. No.: Ward: DOA:
4. Address:
5. Occupation: Income:
6. Educational Standard:

CHIEF COMPLAINTS:

HISTORY OF PRESENTING ILLNESS:

1. Cough Duration
2. Expectoration if any Nature
3. Chest Pain Duration
4. Dyspnoea Duration
5. Haemoptysis Duration
6. Fever Duration
7. Generalised. ill-health Duration
8. Weight Loss Duration
9. Dysphagia
10. Hoarseness of voice
11. Pain Abdomen
12. Headache 13. Backache
14. Any other complaints

RISK FACTORS:

1. Smoking - Pack-yrs
2. DM
3. Occupational exposure

4. Exposure to TB / STD
5. Immuno-suppresive conditions

HISTORY OF PAST ILLNESS:

EXAMINATION:

General Examination:

Respiratory system:

Abdomen:

Other systems:

Sign of Para-neoplastic syndrome:

INVESTIGATIONS:

1. **Routine:**

Haemogram

Blood Sugar Urea Creatinine

Urine RE

Tuberculin Test

2. **Sputum Examination:**

Gram stain
AFB stain
Fungal KOH stain
Bacterial C/S
Malignant cell

3. Chest Xray PA/ lateral/ digitally enhanced x-ray: Nodule

Site
Size
Margin Charecteristics
Calcification
Growth rate
Any other finding

4. CT Thorax: Nodule

Site
Size
Margin Charecteristics
Calcification
Growth rate
Densitometry
Contrast enhancement
Feeding vessel sign
Thickness of cavitary wall if any

5. Trans-thoracic CT guided needle aspiration / biopsy

Histo-pathological report
Any complication of procedure

6. Fibre-optic Bronchoscopy and lavage / brushing / biopsy

Histo-pathological report
Any complication of procedure

7. Lymph node aspiration cytology/excision biopsy

Histo-pathological report

FINAL DIAGNOSIS:

ABBREVIATIONS

Lt. – Left

Rt. – Right

UL – Upper lobe

ML – Middle lobe

LL – Lower lobe

CEN – Cetral

PER – Peripheral

Occu. – Occupational

Immuno Rx. – Immuno-suppresive drugs

NA – Not applicable

Min. – Minimal

LN – Lymph node

TTNA – Trans-thoracic needle aspiration

Comparative report of other Indian studies with present study[90,91,92,93, 94,95,96,97,98]

STUDY	Author	Total cases	M:F ratio	Avg. age	Smoker: Non-smoker	Squamous cell Ca (%)	Large cell Ca (%)	Adeno Ca (%)	Small cell Ca (%)	Unclassified (%)
90	Viswanathan et al	95				50.5		28.4		21.1
90, 91	Shankar et al	20	All M	54	5.7	73.3		20	6.7	
91, 92	Nagrath et al	35	4	47.7	1.9	25.7		34.3		40
92, 93	Jha et al	25	2.9	46.6	5.3	44		20	20	20
93, 94	Narang et al	58	8.7	51.3	4.8	37.9		10.4	51.8	
94, 95	Malhotra et al	70	7.8	49.6	4.8	50	7	14.3	13.7	17.1
95, 96	Jindal et al	1009	4.5	54.3	2.7	34.3	7.3	25.9	26.3	12.2
96, 97	Arora et al	100	4.6	50	1.5	27	10	21	1	3
97, 98	Sahu et al	25	11.5:1	59.3	4.1	50		25	8.3	8
PRESENT STUDY		50	24.1	53.8	6.8	48		33	11	8

S.NO	I.P.NO	AGE	SEX	DIAGNOSIS	SMOKING (PACK-YRS)	OTHER RISK FACTORS	SYMPTOMS	DURATION OF SYMPTOM	SIGNS
1	40453	53	MALE	SQUAMOUS CELL CA	21-40	OCCU. EXP	ASYMPTOMATIC	N A	CLUBBING
2	40632	52	MALE	TB	>40	IMMUN RX	DRY COUGH	1-2	MIN. LUNG SIGN
3	40672	47	MALE	ADENOCARCINOMA	1-20	OCCU. EXP	ASYMPTOMATIC	N A	NO SIGN
4	40709	69	MALE	SQUAMOUS CELL CA	>40	NIL	CHEST PAIN	0-0.5	CERVICAL LN
5	40777	53	MALE	SQUAMOUS CELL CA	21-40	NIL	ILL HEALTH	1-2	NO SIGN
6	40823	25	MALE	SMALL CELL CA	NON-SMOKER	NIL	CHEST PAIN	1-2	NO SIGN
7	40845	48	MALE	TB	1-20	STD	HAEMOPTYSIS	0-0.5	MIN. LUNG SIGN
8	40891	37	FEMALE	ROUND PNEUMONIA	NON-SMOKER	DM	DRY COUGH	0-0.5	MIN. LUNG SIGN
9	40919	45	MALE	METASTASIS	>40	OCCU. EXP	CHEST PAIN	0.5-1	CERVICAL LN
10	40953	47	MALE	PNEUMONIA/ABSCESS	1-20	STD	DRY COUGH	0-0.5	MIN. LUNG SIGN
11	40978	52	MALE	SQUAMOUS CELL CA	21-40	NIL	ASYMPTOMATIC	N A	NO SIGN
12	40995	65	MALE	SQUAMOUS CELL CA	>40	OCCU. EXP	ILL HEALTH	2-3	CERVICAL LN
13	41032	55	MALE	PNEUMONIA/ABSCESS	1-20	DM	DRY COUGH	0-0.5	MIN. LUNG SIGN
14	41058	65	MALE	MUCOID IMPACTION	>40	IMMUN RX	EXPECTORATION	0-0.5	MIN. LUNG SIGN
15	41079	48	MALE	ADENOCARCINOMA	1-20	NIL	ASYMPTOMATIC	N A	NO SIGN
16	41082	58	MALE	PNEUMONIA/ABSCESS	1-20	DM	DRY COUGH	0-0.5	MIN. LUNG SIGN
17	41110	66	MALE	TB	21-40	OCCU. EXP	DRY COUGH	0.5-1	MIN. LUNG SIGN
18	41141	55	MALE	SQUAMOUS CELL CA	>40	DM	CHEST PAIN	0.5-1	CLUBBING
19	41167	54	MALE	SQUAMOUS CELL CA	>40	NIL	ILL HEALTH	2-3	NO SIGN
20	41275	49	MALE	PSEUDO-TUMOUR	1-20	DM	ASYMPTOMATIC	N A	MIN. LUNG SIGN
21	41313	45	FEMALE	TB	NON-SMOKER	DM	EXPECTORATION	0-0.5	MIN. LUNG SIGN
22	41497	56	MALE	ADENOCARCINOMA	21-40	NIL	ASYMPTOMATIC	N A	NO SIGN

23	41620	44	MALE	HAMARTOMA	21-40	NIL	ASYMPTOMATIC	N A	NO SIGN
24	41771	51	MALE	PSEUDO-TUMOUR	21-40	TB	ASYMPTOMATIC	N A	NO SIGN
25	41811	63	MALE	SQUAMOUS CELL CA	21-40	DM	ASYMPTOMATIC	N A	CLUBBING
26	41950	77	MALE	SQUAMOUS CELL CA	>40	NIL	DRY COUGH	0.5-1	SKIN NODULE
27	41973	40	MALE	NO DEFINITE DX	1-20	IMMUN RX	ASYMPTOMATIC	N A	NO SIGN
28	42068	47	MALE	SARCOIDOSIS	NON-SMOKER	NIL	DYSPNOEA	0.5-1	MIN. LUNG SIGN
29	42195	56	MALE	ADENOCARCINOMA	21-40	NIL	ASYMPTOMATIC	N A	MIN. LUNG SIGN
30	42236	61	MALE	CARCINOID	21-40	NIL	CHEST PAIN	0.5-1	NO SIGN
31	42250	36	MALE	NO DEFINITE DX	NON-SMOKER	TB	ASYMPTOMATIC	N A	NO SIGN
32	42410	56	MALE	ADENOCARCINOMA	1-20	NIL	ASYMPTOMATIC	N A	MIN. LUNG SIGN
33	42539	59	MALE	SQUAMOUS CELL CA	>40	NIL	DYSPNOEA	0.5-1	MIN. LUNG SIGN
34	42789	48	MALE	TB	NON-SMOKER	NIL	EXPECTORATION	0-0.5	MIN. LUNG SIGN
35	42886	65	MALE	SQUAMOUS CELL CA	>40	NIL	ILL HEALTH	>3	CLUBBING
36	43108	65	MALE	ADENOCARCINOMA	>40	NIL	ILL HEALTH	>3	CLUBBING
37	43222	32	MALE	PNEUMONIA/ABSCESS	NON-SMOKER	DM	EXPECTORATION	0-0.5	MIN. LUNG SIGN
38	46701	62	MALE	TB GRANULOMA	21-40	TB	ASYMPTOMATIC	N A	MIN. LUNG SIGN
39	46993	64	MALE	TB	21-40	TB	EXPECTORATION	0-0.5	MIN. LUNG SIGN
40	47456	48	MALE	ADENOCARCINOMA	NON-SMOKER	NIL	ASYMPTOMATIC	N A	NO SIGN
41	47752	59	MALE	TB GRANULOMA	>40	OCCU. EXP	EXPECTORATION	0-0.5	MIN. LUNG SIGN
42	50123	59	MALE	SQUAMOUS CELL CA	>40	NIL	DRY COUGH	0.5-1	MIN. LUNG SIGN
43	50224	64	MALE	SMALL CELL CA	>40	OCCU. EXP	HAEMOPTYSIS	0-.0.5	CERVICAL LN
44	52673	48	MALE	ADENOCARCINOMA	21-40	NIL	ASYMPTOMATIC	N A	NO SIGN
45	58752	60	MALE	SMALL CELL CA	>40	NIL	DRY COUGH	0-0.5	HEPATOMEGALY
46	60539	55	MALE	NO DEFINITE DX	1-20	DM	ILL HEALTH	>3	NO SIGN
47	60972	52	MALE	NO DEFINITE DX	NON-SMOKER	NIL	ASYMPTOMATIC	N A	NO SIGN
48	61949	48	MALE	ADENOCARCINOMA	21-40	NIL	ASYMPTOMATIC	N A	MIN. LUNG SIGN
49	62432	61	MALE	SQUAMOUS CELL CA	>40	OCCU. EXP	WT. LOSS	1-2	CERVICAL LN
50	64659	44	MALE	NO DEFINITE DX	21-40	OCCU. EXP	DRY COUGH	0-0.5	NO SIGN

CHARECTERISTICS OF NODULE						WBC COUNT	ESR	BLOOD SUGAR (PP)	SPUTUM	INVASIVE INVESTIGATION
SITE	SIZE(CM)	MARGIN	THICKNESS OF CAVITY WALL(MM)	CALCIFICATION	CONTRAST ENHANCEMENT					
LT.UL, CEN	5	SMOOTH	NON CAVITARY	NIL	>20 HU	8400	HIGH	128	MALIG. CELL +	BRONCHOSCOPY BIOPSY
RT.UL, CEN	2.8	SMOOTH	NON CAVITARY	BENIGN	>20 HU	13000	LOW	146		BRONCHOSCOPY LAVAGE
RT.LL, PER	5	SPICULATED	NON CAVITARY	NIL	>20 HU	1250	HIGH	138		TTNA/BIOPSY
RT.UL, PER	5	SPICULATED	NON CAVITARY	NIL	<15HU	8600	HIGH	102		CER.LN.FNAC/BIOPSY
RT.UL, CEN	4.5	SPICULATED	NON CAVITARY	NIL	>20 HU	8600	MODERATE	146		BRONCHOSCOPY BIOPSY
LT.ML, PER	4	SMOOTH	NON CAVITARY	NIL	>20 HU	6300	HIGH	122		TTNA/BIOPSY
LT.UL, CEN	2.7	SMOOTH	<4	BENIGN	>20 HU	8100	HIGH	134		BRONCHOSCOPY LAVAGE
LT.UL, PER	2	SPICULATED	NON CAVITARY	NIL	>20 HU	12000	HIGH	194	C/S +	TTNA
LT.LL, PER	2.1	SMOOTH	NON CAVITARY	NIL	<15HU	8000	LOW	152		CER. LN. FNAC/BIOPSY
LT.UL, PER	4	SMOOTH	NON CAVITARY	NIL	>20 HU	9960	HIGH	110	C/S +	TTNA
LT.UL, CEN	5	SPICULATED	NON CAVITARY	NIL	>20 HU	6680	HIGH	104		BRONCHOSCOPY BIOPSY
RT.LL, PER	5	SPICULATED	NON CAVITARY	NIL	>20 HU	11700	MODERATE	120		CER. LN.FNAC/BIOPSY
LT.UL, PER	2.3	SMOOTH	NON CAVITARY	NIL	>20 HU	10200	HIGH	268		TTNA
RT.LL, CEN	6	SMOOTH	NON CAVITARY	NIL	<15 HU	8200	LOW	104		BRONCHOSCOPY LAVAGE
RT.LL, PER	4.5		NON CAVITARY	NIL	>20 HU	6000	HIGH	127		TTNA/BIOPSY
LT.UL, PER	4	SMOOTH	NON CAVITARY	NIL	>20HU	8320	LOW	242		TTNA
RT.UL, CEN	2.6	SMOOTH	<4	BENIGN	>20 HU	6490	MODERATE	106		BRONCHOSCOPIC LAVAGE
LT.UL, PER	6	SPICULATED	NON CAVITARY	NIL	>20 HU	14000	MODERATE	202		TTNA/BIOPSY
RT.UL, CEN	5	SPICULATED	NON CAVITARY	NIL	<15HU	6800	MODERATE	110		BRONCHOSCOPY BIOPSY
LT.UL, CEN	6	SMOOTH	NON CAVITARY	NIL	<15 HU	11100	LOW	238		NIL
RT.UL, PER	3	SMOOTH	4-15	BENIGN	<15 HU	9240	HIGH	372	SPUTUM AFB +	NIL
RT.UL, PER	6	SPICULATED	NON CAVITARY	NIL	>20 HU	6800	HIGH	125		TTNA/BIOPSY

RT.ML, PER	5	SMOOTH	NON CAVITARY	BENIGN	>20 HU	8200	HIGH	140		TTNA/BIOPSY
LT.LL, CEN	2.9	SMOOTH	NON CAVITARY	NIL	>20 HU	9600	MODERATE	122		NIL
LT.UL, CEN	6	SMOOTH	NON CAVITARY	NIL	>20 HU	14000	LOW	222	MALIG. CELL +	BRONCHOSCOPY BIOPSY
RT.UL, CEN	3.9	SPICULATED	NON CAVITARY	NIL	>20 HU	9700	HIGH	104		BRONCHOSCOPY BIOPSY
RT.LL, PER	4	SMOOTH	NON CAVITARY	NIL	<15 HU	8700	LOW	111		TTNNA/BIOPSY
RT. LL, PER	4	SMOOTH	NON CAVITARY	BENIGN	<15 HU	4600	HIGH	130		TTNA/BIOPSY
RT.UL, PER	5	SPICULATED	NON CAVITARY	NIL	>20 HU	8500	HIGH	132		TTNA/BIOPSY
LT.LL, CEN	4	LOBULATED	NON CAVITARY	STIPPLED	<15 HU	11200	LOW	137		BRONCHOSCOPY BIOPSY
LT.LL, CEN	4	SMOOTH	NON CAVITARY	NIL	<15 HU	9600	MODERATE	110		BRONCHOSCOPY LAVAGE
RT.UL, PER	5	SMOOTH	NON CAVITARY	NIL	>20 HU	12000	HIGH	108		TTNA/BIOPSY
RT.UL, CEN	3.9	SPICULATED	NON CAVITARY	NIL	>20 HU	9400	HIGH	120		BRONCHOSCOPY BIOPSY
RT.LL, CEN	6	SMOOTH	<4	BENIGN	<15 HU	7600	LOW	122	SPUTUM AFB +	NIL
RT.LL, CEN	5	SPICULATED	NON CAVITARY	NIL	>20 HU	9000	HIGH	130		BRONCHOSCOPY BIOPSY
RT.UL, PER	4	LOBULATED	NON CAVITARY	NIL	>20 HU	8100	LOW	106		TTNA/BIOPSY
RT.LL, PER	5	SMOOTH	NON CAVITARY	NIL	>20 HU	12000	HIGH	312	C/S +	TTNA
LT.UL, PER	3	SMOOTH	NON CAVITARY	BENIGN	<15 HU	4200	HIGH	102		TTNA
RT.UL, PER	4.5	SMOOTH	NON CAVITARY	BENIGN	>20 HU	5800	MODERATE	136	SPUTUM AFB +	NIL
LT.UL, PER	4.5	SPICULATED	NON CAVITARY	NIL	>20 HU	7600	LOW	122		TTNA/BIOPSY
RT. UL, PER	4	SMOOTH	NON CAVITARY	NIL	<15HU	7500	HIGH	130		TTNA
RT.LL, PER	3	SMOOTH	>15	NIL	>20 HU	8400	LOW	120		TTNA/BIOPSY
RT.ML, CEN	4.5	SPICULATED	NON CAVITARY	NIL	>20 HU	14000	HIGH	125		CER. LN. FNAC/BIOPSY
LT.UL, CEN	5	SMOOTH	NON CAVITARY	NIL	<15HU	6530	MODERATE	122		BRONCHOSCOPY BIOPSY
RT.LL, CEN	5	SPICULATED	NON CAVITARY	NIL	>20 HU	12000	MODERATE	126		BRONCHOSCOPY BIOPSY
RT.LL, CEN	4	SMOOTH	NON CAVITARY	NIL	<15HU	7000	MODERATE	238		BRONCHOSCOPY LAVAGE
LT.LL, PER	1.8	SMOOTH	NON CAVITARY	NIL	<15HU	9400	MODERATE	130		TTNA/BIOPSY
LT.LL, PER	3.5	SMOOTH	NON CAVITARY	NIL	>20 HU	8600	LOW	100		TTNA/BIOPSY
RT.UL, PER	4	SMOOTH	4-15	NIL	<15HU	7520	HIGH	134		CER. LN.FNAC/BIOPSY
RT.UL, CEN	4.2	SMOOTH	NON CAVITARY	NIL	<15HU	6680	HIGH	107		BRONCHOSCOPY LAVAGE